Special Machines in a Typewriter Plant

Unusual Mechanisms Incorporated in the Design of Special High-production Machines

By CARL GABRIELSON, L. C. Smith & Bros. Typewriter Co., Syracuse, N. Y.

INVENTIVE genius has a greater opportunity in the development of special metal-working machines intended for single-purpose operations than it has in the design of more or less standard machine tools. In the latter, the movements of the various members are generally obtained through mechanisms that are similar for machines of the same class, even though built by different manufacturers, and so the designer at the outset knows fairly well the means by which desired results will be accomplished. But in developing a machine for performing an operation for which no standard machine is adapted, the designer is forced to rely upon his knowledge of mechanisms, and his experience and inventive ability.

The present article describes a number of mechanisms employed in single-purpose machines developed in the engineering department of the L. C. Smith & Bros. Typewriter Co., Syracuse, N. Y., for operations on typewriter parts. When it is known that this typewriter is composed of 2568 parts, most of which are of small dimensions, it will be realized that many unusual machines are employed in its production. The mechanisms to be described could be modified for application to machines intended for other purposes.

Continuous Six-spindle Counterboring Machine

A counterboring machine, the operation of which is automatic except for placing the work on an indexing drum, is illustrated in Fig. 1. This machine is employed to produce a groove A in the eyelet end of the type-bar hanger shown in Fig. 3, and to face surface B. Six pieces of work are machined at one time, being held on little jig plates that rest on flat surfaces on the turret A, Fig. 1. Each piece is held in place by four pins, and by having the shank end come in contact with a small upright piece at one end of the jig plate. The pieces are also clamped firmly on the table by means of a finger reaching down along the counterbored spindle, as illustrated in Fig. 6. This finger holds the piece firmly, due to the pressure of the coil spring in the bearing at the upper end of the finger. The interesting feature of
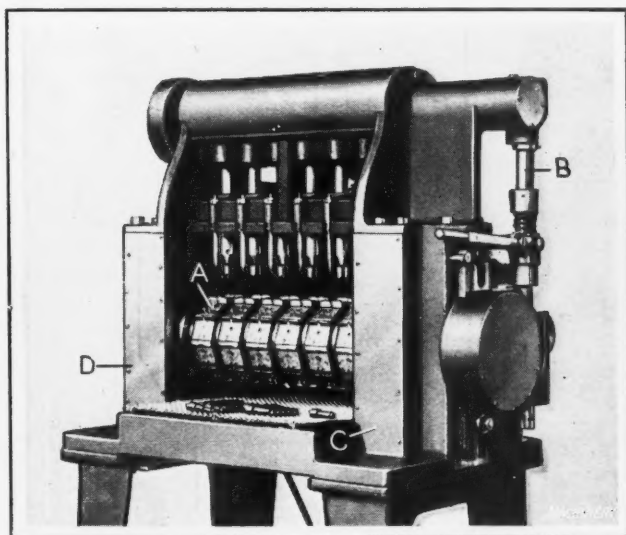

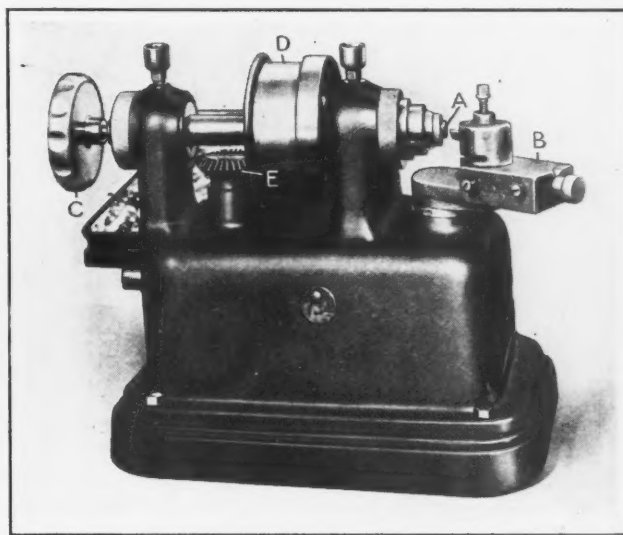Fig. 1. Six-spindle Counterboring Machine equipped with a Turret that has Rotary and Vertical Movements

Fig. 2. Machine employed in rounding the Ball Race of the Type-bar Hanger illustrated in Fig. 3
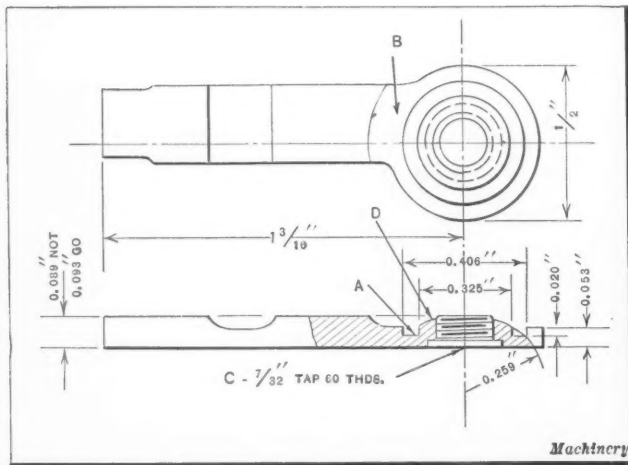
Fig. 3. Type-bar Hanger used in Smith Typewriter

Fig. 4. Detailed Views of Type Bar

this machine is that the turret is not only indexed to bring successive rows of pieces beneath the six cutter-spindles, but is also raised between each indexing to bring the pieces to the cutters. The turret is indexed ten times per revolution. An average production of 1000 parts per hour is obtained on this machine.

The drive to the cutter-spindle is transmitted from the main driving shaft at the top of the machine through six pairs of spiral gears. Each spindle is provided with a close adjustment for setting the counterbore to compensate for wear and resharpenings. Power for revolving and traversing the turret is derived from vertical shaft B, which is driven by spiral gears from the driving shaft. A clutch on shaft B provides for engaging and disengaging the drive. The rotation of the turret is accomplished through a worm on the lower end of shaft B which engages with a worm-wheel on the turret shaft.

Within the housing at C and D are located the indexing and traversing mechanisms. The traversing mechanisms are identical on both sides of the machine, but the indexing mechanism is provided on the right-hand side only. The mechanisms on the right-hand side of the machine are illustrated in the diagrams Figs. 5 and 7. Referring to the sectional view $E–F$, Fig. 7, it will be seen that part H is a disk cam which rides on roller I, and thus raises and lowers the turret once at each revolution of the worm-shaft. The height of roller I can be adjusted to regulate closely the raised and lowered positions of the turret faces.

As the turret reaches the highest position, it is located accurately for the counterboring operation by a spring-

actuated tooth K, Fig. 5, which engages a notch in the periphery of plate J. On the downward movement of the turret, lever L swivels slightly so that tooth K is held in the notch in plate J by spring M until the work has cleared the counterbores. Then as the turret continues its downward movement, the upper end of finger N, as shown in the sectional view $C–D$, Fig. 7, enters a notch in plate O and indexes the plate and the turret. In both sectional views in Fig. 7, the turret is represented as being in the lowest position.

Machine for Rounding the Ball Race of the Type-bar Hanger

On the Smith typewriter, the type-bar hanger (Fig. 3), the type bar (Fig. 4), and a third part that screws into hole C in the hanger are assembled together by means of a lock-screw which engages the threads of a tapped hole in the center of the third part, and which has a head that seats in the counterbored portion of hole C. A rounded surface D on the hanger and a similarly rounded surface on the third part form a groove or race between which and groove A in the type bar, are retained fifteen 1/16-inch balls that provide easy movements of the type bar when the unit is assembled into a typewriter. The construction of this unit permits a very fine adjustment. The rounding of surface D is accomplished on the machine illustrated in Figs. 2 and 8 after hole C has been tapped.

Briefly, the operation consists of mounting the hanger on the end of a screw that projects from part A, and rounding the ball surface, as the work revolves, with a tool mounted in the holder on table B. The table is automatically swivelled
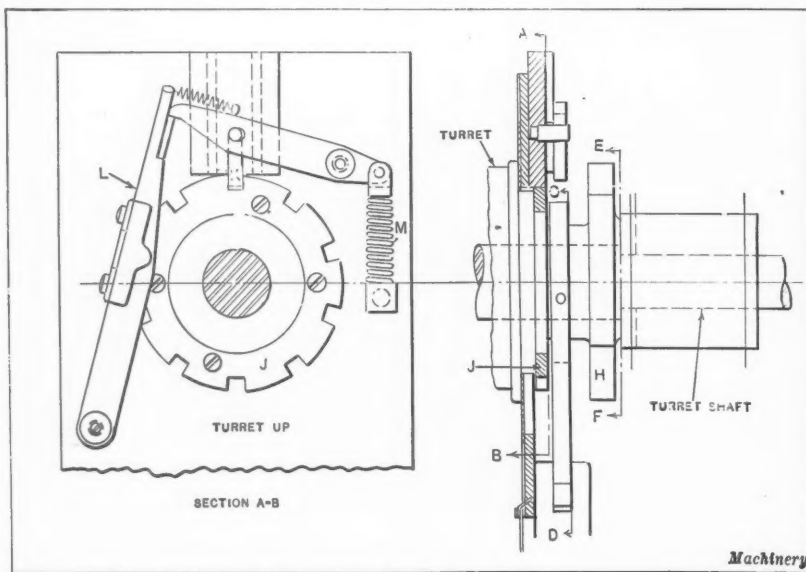
Fig. 5. Mechanism for indexing and traversing the Turret of the Counterboring Machine
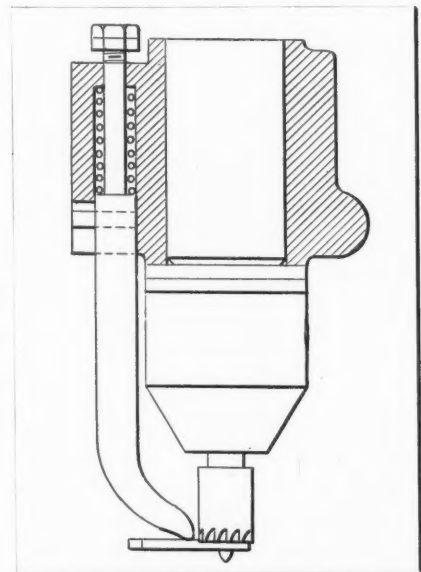
Fig. 6. Holding Finger on Cutter-spindles

from right to left to suit the radius of the rounded surface. When the ball race is finished, the feed is automatically stopped and the tool-holder returned to the starting position before the work is removed. The construction of the machine is so rigid and the cut so light that the tool, in returning over the finished surface, does not mark the work. The work is quickly

Fig. 7. Sectional Views of the Mechanism shown in Fig. 5

mounted on the screw by simply holding the tapped hole against the end of the screw and revolving handwheel *C* to draw the hanger tightly in place.

The means by which table *B* is swiveled and the machine automatically stopped at the end of an operation are of especial interest. Power is delivered to pulley *D* on the spindle of the machine by belt from an overhead counter-shaft. Pulley *D* is mounted on the sleeve of one bevel gear of a pair *E*, through which the spindle is rotated. The other mechanisms of the machine are operated through bevel gears *E* and *F* (Fig. 8) which transmit motion to a shaft at the bottom of the machine on which worm *G* is mounted. This worm, through a worm-wheel, drives the vertical shaft on which the cam *H* is mounted that controls the automatic operation of the machine.

At the lower end of shaft *I*, to which table *B* is attached, there is an arm *J* carrying a roller that is held constantly against the periphery of the cam by spring pressure. Thus table *B* is swiveled according to the contour of the cam. A block on the upper surface of cam *H* operates lever *K* at the end of the operation, and stops the machine. The movement of lever *K* releases lever *M*, which, through spring *N*, brings brake *O* in contact with the flange on pulley *D*. At the same time the countershaft belt is shifted from the tight to the loose pulley by means of a connection between the shifting mechanism and the outer end of lever *M*. In starting the machine, the countershaft belt is shifted from the loose to the tight pulley by depressing a foot-treadle, which at the same time pulls down the outer end of

lever *M* until the upper hooked end of lever *K* again engages block *L*. One workman can tend four of these machines at one time, the net production being about 135 pieces per machine per hour.

Grooving the Type Bar

Groove *A*, Fig. 4, in the type bar is rough- and finish-turned in the machine illustrated in Figs. 9 and 10, by using a single two-lipped circular forming cutter, which is approximately 5/16 inch outside diameter. The cutter is held stationary in a vertical position. After the work has been clamped on the table in the position indicated by the dot-and-dash lines at *X*, Fig. 9, by means of a quick-acting arrangement, the cutter-spindle is lowered to bring the cutting lips of the tool in line with the work to be grooved. Then, when the machine is started, the cutter-slide moves toward the rear, and one of the cutter lips takes a roughing cut, after which the slide moves forward and the second lip takes the finishing cut. The slide next moves slightly to the rear again, bringing the cutter to the center of the grooved hole, at which time the cutter-head is automatically raised and the machine stopped. These various movements are all obtained through cams.

It will be seen from Fig. 9 that the machine is driven through pulley *A* which is located near the base of the machine on a vertical shaft at the top of which the revolving work-table is attached. Worm *B* on the same shaft delivers power through worm-wheel *C* to the shaft on which the worm-wheel is mounted. On each side of worm-wheel *C* there is a cam *D* against which a roller on the lower end of link *E* contacts. The upper end of the link is attached to the rear of the cutter-slide *G*. Coil spring *F* serves to hold the roller constantly against the cam, so as to swivel link *E* to and fro as the cam revolves. This movement of the link causes the tool-slide to withdraw and advance for roughing and finishing the groove, and to withdraw prior to raising the spindle, as explained in the foregoing.
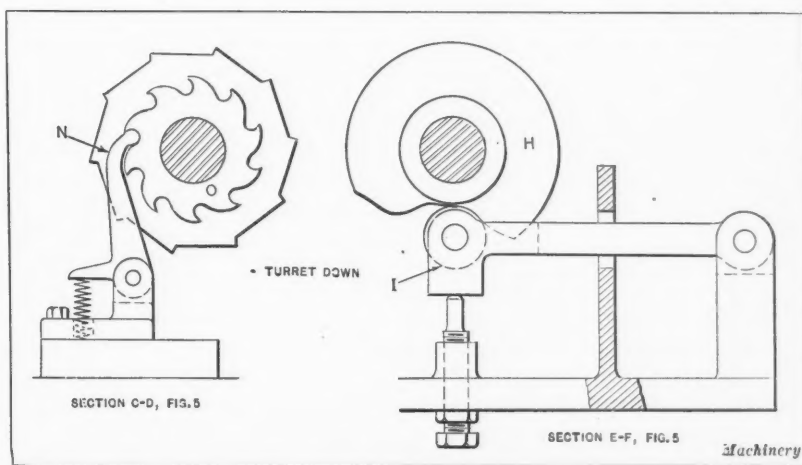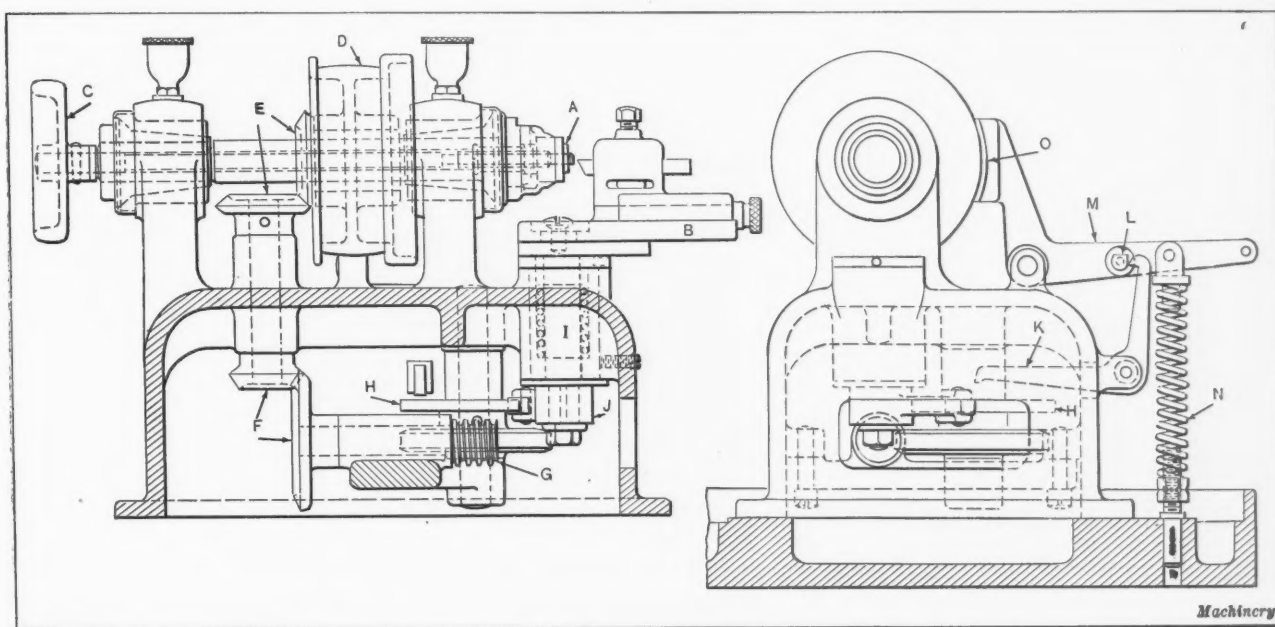
Fig. 8. Assembly Views showing the Construction of the Hanger-turning Machine illustrated in Fig. 2

On the left-hand end of the shaft on which worm-wheel C is mounted, there is another small cam H which comes in contact with the upper end of lever I. This lever is connected through links and rods to the belt-shifting mechanism. When lever I is swiveled by cam H, the forward end of lever J is released, and the shaft to which lever J is attached is swiveled through the action of spring K, causing the belt shifting mechanism to throw the countershaft belt on the loose pulley.

Simultaneously with this action, a third cam L on the right-hand side of the worm-wheel shaft strikes the lower end of the vertical rod M, raising this rod and causing the bellcrank lever N to swivel so that its upper end slides off the cam surface of part O. This releases the shaft on which part O is mounted, and permits gear segment P to be turned on its axis by a spring. The teeth of this segment engage

a rack on the tool-spindle, so that the spindle is raised as the segment swivels. At the same time a guard which surrounds the work during the operation is raised by means of lever Q. A third arm on lever N engages a small pin R on rod S, and withdraws this rod from engagement with the lower end of the cutter-spindle just prior to the raising of the spindle. The function of rod S is to hold the cutter-spindle in the desired radial and vertical positions relative to the work.

When the work has been placed on the table at the beginning of an operation, the cutter-spindle and guard are lowered to the operative position by raising handle Q to bring the upper end of lever N on the cam surface of part O. At the same time rod S is pushed forward to lock the cutter-spindle in position. The machine is then started by depressing a foot-treadle which operates the belt shifter
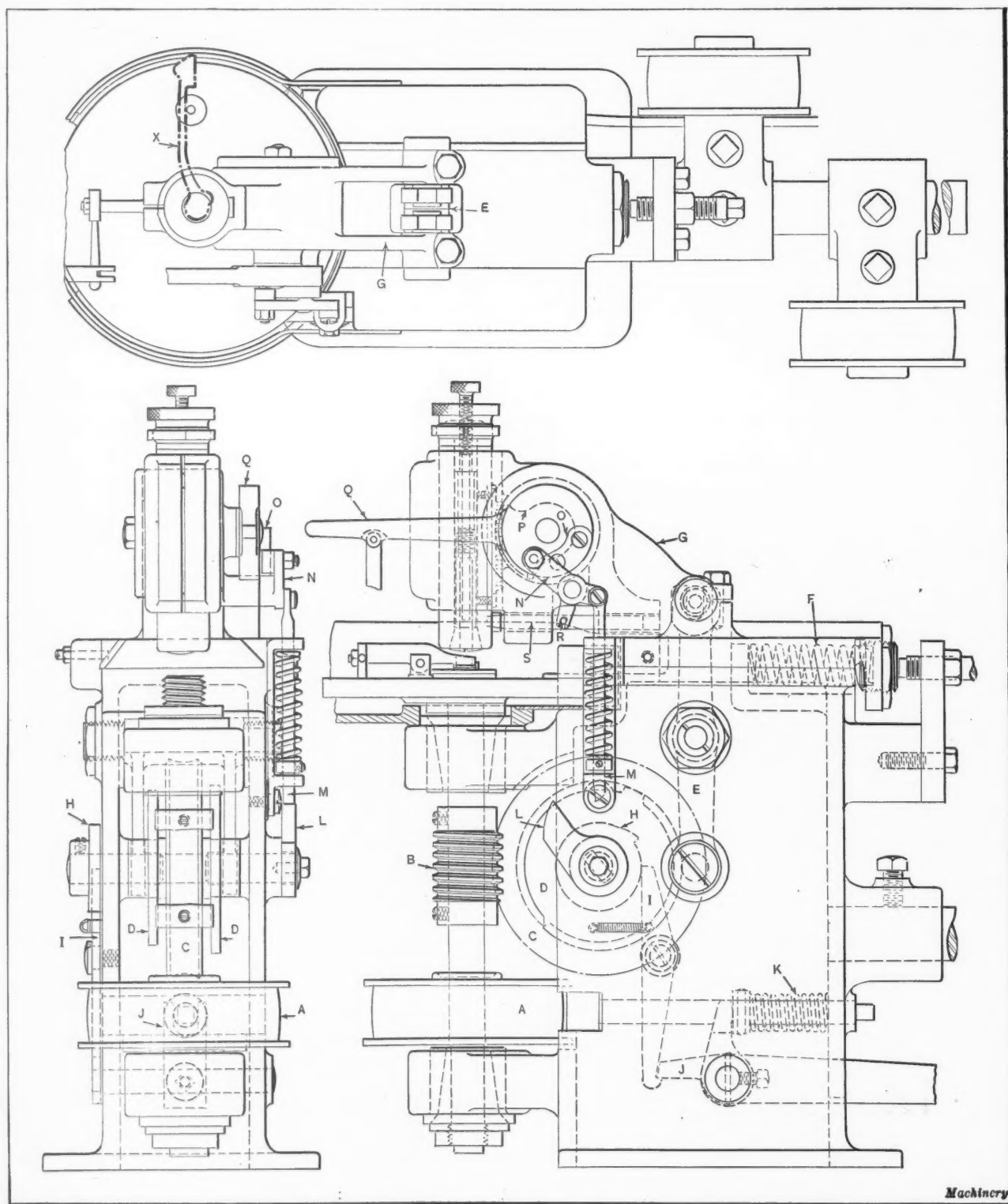
Fig. 9. Assembly Views of Machine for producing the Ball Groove in the Type Bar
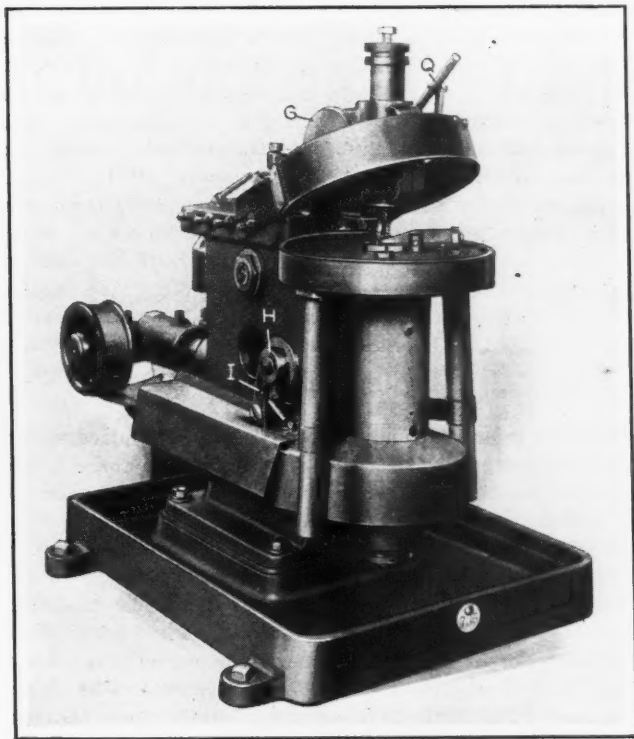
Fig. 10. Machine used for producing the Ball Groove in the Type Bar, Assembly Views of which are shown in Fig. 9

and again raises the forward end of lever *J* into engagement with lever *I*. A micrometer adjustment is provided for accurately positioning the cutter. One operator serves two machines of this type, and averages a net production of about 150 pieces per hour on each machine. It will be seen that in Fig. 9 the plan view is not placed directly above the side elevation. A description of four other unique machines used in the same plant as those described in the foregoing will appear in October MACHINERY, in the second installment of this article.

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DESIGN OF BROACH GUIDE BUSHINGS

By GEORGE E. HODGES

There seems to be a wide difference of opinion as to the best practice in the design of broach guide bushings. The steel bushing commonly used is, in the writer's opinion, very inefficient. With this type of bushing the thrust of the cut is taken on the face through which the broach must pass. This design has two disadvantages: First, some of the cutting teeth are sacrificed to provide the extra broach-shank necessary for taking the thrust on surface *E*, which directly shortens the life of the tool; second, the guide is made so close to the size of the broach that the slightest misalignment between the two will cause an overload on the broach, because it must cut both the work and the bushing. This overload, while it may not break the tool, will certainly decrease its life.

The reason for having the bushing close-fitting is that it prevents the work, to some extent, from tearing out. When the material tears out, there is something the matter with the broach or the material being cut. The broach should be inspected for dull or poorly formed teeth, which will show up on a visual inspection. Dulled corners or cutting edges, if there are any, would cause this tearing. If the broach seems to be in good condition, the material being broached should be examined.

Mild forgings, such as are used for yokes, spiders, gear blanks, etc., often give trouble. The general symptom is that after a few pieces are taken from the broach, the work begins to tear out. The broach has been dulled a little in doing the work, and the material is too mild to machine well, except with a tool that is in prime condition. The

best way to remedy this trouble is to heat-treat the work so that it can stand machining with average tools.

One large manufacturer of six-cylinder cars found that by heat-treating the universal joint yokes, not only were broach costs reduced, but large savings were effected on die, reamer, and cutter costs. Production was speeded up and an excellent finish brought to the work at every point. The trouble in this case started after fifty to sixty pieces were taken from a new broach. After heat-treating the work, 6500 pieces, on the average, were finished with each broach.

One manufacturer turns or chamfers off the damaged end of the work so that the tear will not show. Another chamfers the end that is likely to be damaged, so that as the broach leaves the hole only a small tear, if any, occurs. Heat-treating the pieces is the best method, as it makes the work easier for all the tools used after the rough-turning, which is the best point at which to apply the heat-treatment.

The guide bushing *A* shown in the accompanying illustration is enjoying wide favor in shops where it has been adopted. It is simply a cast-iron bushing, with dimension *M* made to fit the hole in the faceplate of the broaching machine. In design, it resembles the reducing bushing furnished with the machine. The difference is that the bore is made to directly accommodate the work, using a different thrust surface or face from the one through which the broach must pass. This allows the broach no chance to cut into the bushing.

The work *B*, which is shown in place in the guide bushing is a universal joint yoke. The thrust of the cut is taken on the radius of the piece and of the bushing at *C*. The diameter of the hole to be broached is indicated at *D*. By using the radius for taking the thrust instead of the surface *E*, as is the usual practice, the work is let into the bushing so that more cutting teeth may be added to the broach.

If there is no other way than to take the thrust on the surface *E*, the bore of the bushing should be larger than the largest diameter of the broach with which it is to be used. Of course, there must be surface enough to give sufficient strength for taking the thrust. The bore must be large enough to discount any chance of the broach cutting the bushing, as both would soon fail in productive work. Bushings of this type are not difficult to make as the patterns, castings and machining operations required are very simple.
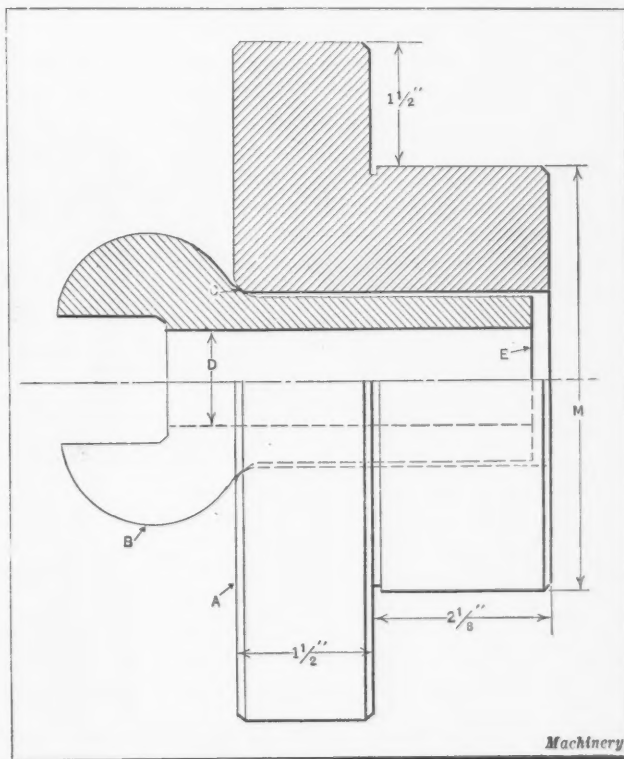
Guide Bushing used in broaching Universal Joint Yoke B

LOCOMOTIVE TESTING LABORATORY

By ROBERT H. MOULTON

A unique locomotive which runs under full steam, and yet at the same time remains stationary, is part of the equipment of the locomotive laboratory of the University of Illinois. The drive wheels of this locomotive rest on wheels mounted on stationary bearings. Thus, with the locomotive in a fixed or stationary position, it is possible to have the drive
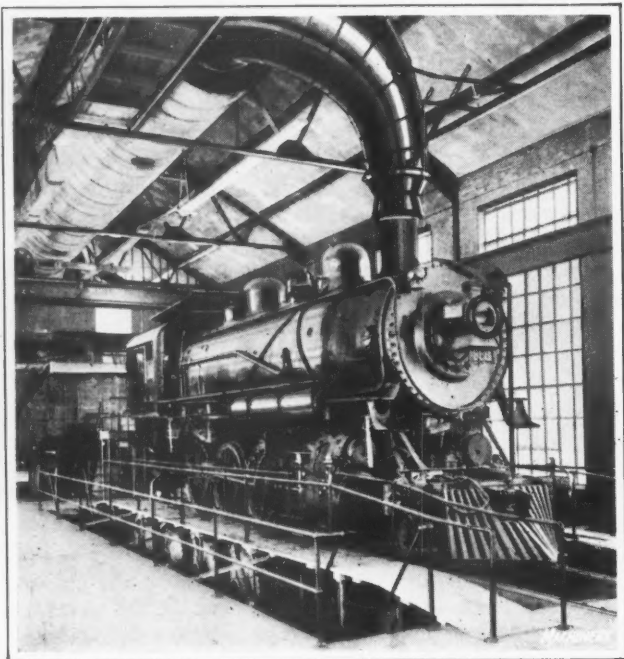
Fig. 1. Locomotive Ready to be subjected to Dynamometer Tests

wheels revolve at a speed that would carry the locomotive over an ordinary railroad track at the rate of forty miles an hour. This locomotive, which is shown in Fig. 1, is used for both instruction and research purposes. Some of the research work made possible by this equipment has already resulted in the solution of numerous problems regarding fuel waste, tonnages, capacities, etc. Many of the investigations along this line have been carried out in cooperation with various railroads and the International Railway Fuel Association.

The mechanism on which the locomotive is supported is shown in Fig. 2. It consists primarily of an axle, axle bearings, and a pair of wheels for each pair of locomotive drivers. These supporting members can be adjusted to suit the wheel-base of any locomotive, thus making it possible to test locomotives other than the one used for college instruction and demonstration purposes. When it is desired to test a locomotive, the tender is removed and the engine backed into the laboratory over a temporary track put down between the supporting wheels. The drivers run on their flanges over the temporary track, which leaves the treads free to engage the supporting wheels, so that when the locomotive is properly placed, the supporting wheels carry all the weight except, of course, that borne by the leading or trailing trucks. The temporary track, then being relieved, may be removed. Mounted in this way, the locomotive is held in place and prevented from moving forward or backward by means of a dynamometer draw-bar, A, Fig. 2, which is supplemented by two safety-bars B that come into play in case of failure of the draw-bar.

The chief function of the dynamometer is to permit the tractive force of the locomotive to be measured. It consists essentially of two parts, a weighing head and a measuring and recording scale. Within the weighing head is an enclosed oil chamber with a flexible wall or diaphragm, which receives and balances any force transmitted through the draw-bar of the locomotive. The pressure within this oil chamber varies with the load, and is transmitted through a copper tube of small bore to a smaller oil chamber known as the reducing chamber, located in the case with the measuring apparatus. The pressure thus produced in the reduction chamber, as a result of running the locomotive, moves the beam of a scale, which measures the tractive force.

Dynamometer Protected from Undue Strains

In order to prevent undue shocks from taking place within the weighing head on account of variations in force in the draw-bar, an initial load of 50,000 pounds is imposed upon the oil behind the diaphragm by means of a capstan and springs located at the rear of the weighing head. The weighing head of the dynamometer is so designed that, by an adjustment of the capstan, the tractive force may be measured whether the locomotive drivers are turning backward or forward. For the sake of accuracy in determining the draw-bar pull, it is essential that the locomotive drivers be placed and maintained with their centers precisely above the centers of the supporting wheels. To satisfy this requirement, the longitudinal travel of the dynamometer draw-bar from no load to full load must be reduced to a minimum. In this instrument the range of movement is only 0.003 inch. The dynamometer will measure draw-bar pulls as high as 125,000 pounds.

Automatic Control of Poise Weight

A feature of interest in the design of the scale lies in the fact that the adjustment of the poise weight on the scale beam may be made automatically. This is accomplished by means of a small motor which is mounted on the scale beam and geared to a screw which passes through the poise weight. Attached to the scale beam is a contact arm, and any movement of the beam in either direction causes a series of mercury-cup contacts, the number of contacts depending on the amount of deflection of the beam, which is caused by a change in the load. When contact is made, an electrical circuit is closed and the motor runs in the direction required to bring the poise weight to a position of equilibrium. When the load is balanced, the circuit is broken and the motor stops.
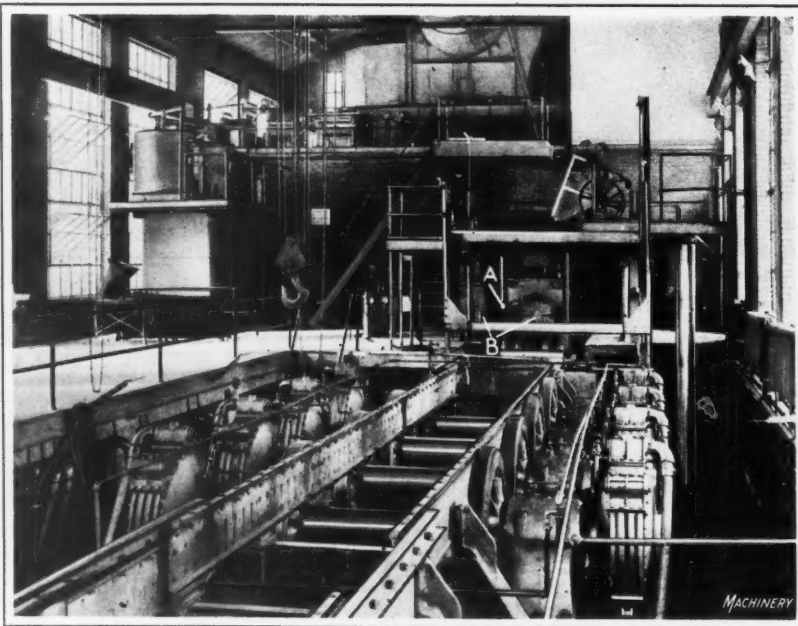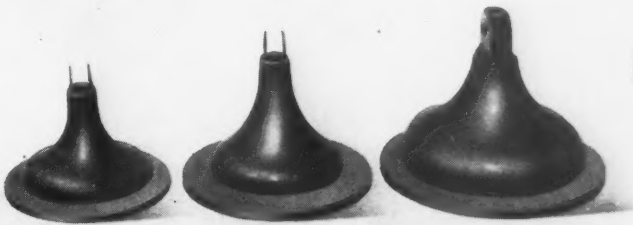

Fig. 2. Close-up View of Locomotive Testing Equipment

Drawing and Perforating Dies for Fan Bases

Procedure in Designing the
Dies for an Electric Fan Base

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HIGHER production rates without a sacrifice in quality is the predominant demand in nearly every manufacturing plant today. In many instances, power presses equipped with special dies have played an important part in meeting these demands. This is particularly true in the case of plants manufacturing such products as electric motors and fans, many parts of which are so designed that it would be practically impossible to turn them out on a commercial basis except by the use of power presses. The electric fan bases shown in the heading illustration are typical examples of such work.

The success or effectiveness of a power press, however, depends on the design of the dies, and it is with this subject that the present article deals. The dies shown in the illustrations were developed at the plant of the Century Electric Co., St. Louis, Mo., and are employed by this company in the production of the electric fan stand shown in the central view of the heading illustration. The smaller stand at the left, and the larger one at the right, are also products of similar dies developed and used at this company's plant.

Determining the Blank Diameter

The first step in designing a set of drawing dies is to determine the blank diameter, the number of drawing operations required, and the amount of draw at each operation. The procedure followed in the case of the fan stand dies shown in Fig. 6 is as follows: A sectional view of the work showing its form after the final drawing operation, is first laid out accurately to scale. This view is then divided into sections, as indicated in Fig. 1, in order to determine the surface area. A complete description of the procedure, as applied to the problem of determining the approximate area of a surface of revolution, is found on page 145 of MACHINERY'S HANDBOOK.

It will be noted from Fig. 1 that the first section at the top of the part is hemispherical, and the next cylindrical, the latter being 1 inch in diameter and 1 inch long. The areas of these sections are found by exact formulas, and the results written down at *A* and *B*, respectively. The next division *C* has an irregular curved surface which is divided into sections by $\frac{1}{8}$-inch divisions set off on line *LM*. Dotted lines are drawn through these division points perpendicular to the vertical axis of the part, as indicated.

Midway between these divisions, full lines are drawn across the figure at right angles to the axis. The diameters, as measured on each full line from the opposite inner surfaces, are then written in the left-hand column headed "Diameter." The diameter of each section is next multiplied by $\pi \times \frac{1}{8}$ to obtain the area of each individual section. These areas are written between the dotted lines in the column headed "Area" and their total set down at *C*. In order to simplify the illustration, the columns headed "Diameter" and "Area" are not shown filled out.

The remaining four divisions below the irregular, curved section consist of a cylindrical surface; the flat part of the base; and the cylindrical part below the flat surface, to which is added $\frac{1}{8}$ inch to allow for trimming. The area of each of these sections is calculated by formulas and written in the proper positions *D*, *E*, *F*, and *G*. The sum of the areas of the individual sections represents the area of the blank. Having the blank area, we obtain the blank diameter by the formula $D = 1.128 \sqrt{A}$, where *D* and *A* are the blank diameter and area, respectively. By writing down the areas of the various sections as indicated, it becomes a comparatively easy matter to determine the number of drawing operations required as well as the amount of draw for each operation.

It is apparent that both sides of the blank have the same area before drawing but that they do not have the same area after the drawing operation has been performed. It would seem, therefore, that the mean diameters of the various sections, instead of their inside diameters, would be taken as a basis for calculating the blank area. However, it was found that a blank having an area equal to that of the inner surface of the object to be drawn, proved satisfactory for cold-rolled steel 5/32 inch and less in thickness. For hot-rolled steel, experience showed that the blank area should be 5 per cent greater than for cold-rolled steel.

Blanking and Drawing Die

The first operation in producing the fan stand consists of blanking and drawing. In making the first draw on a cylindrical shell, it is usual to limit the height of the draw to three-fourths the diameter. The largest section of the work above the flange in this case has a diameter of 4 9/16 inches. It is obvious that the blank, which in this case is 9.226 inches in diameter.

DIAMETER	AREA
1.000	0.3927

COLD ROLLED STEEL 0.036″ THICK
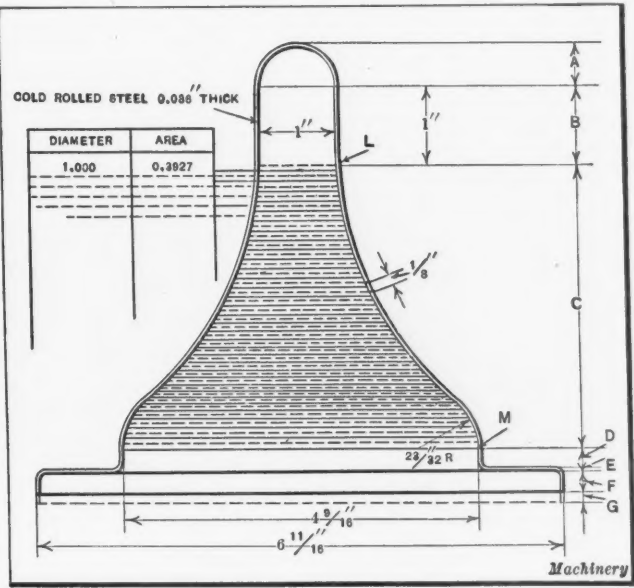
Fig. 1. Method of determining Blank Area
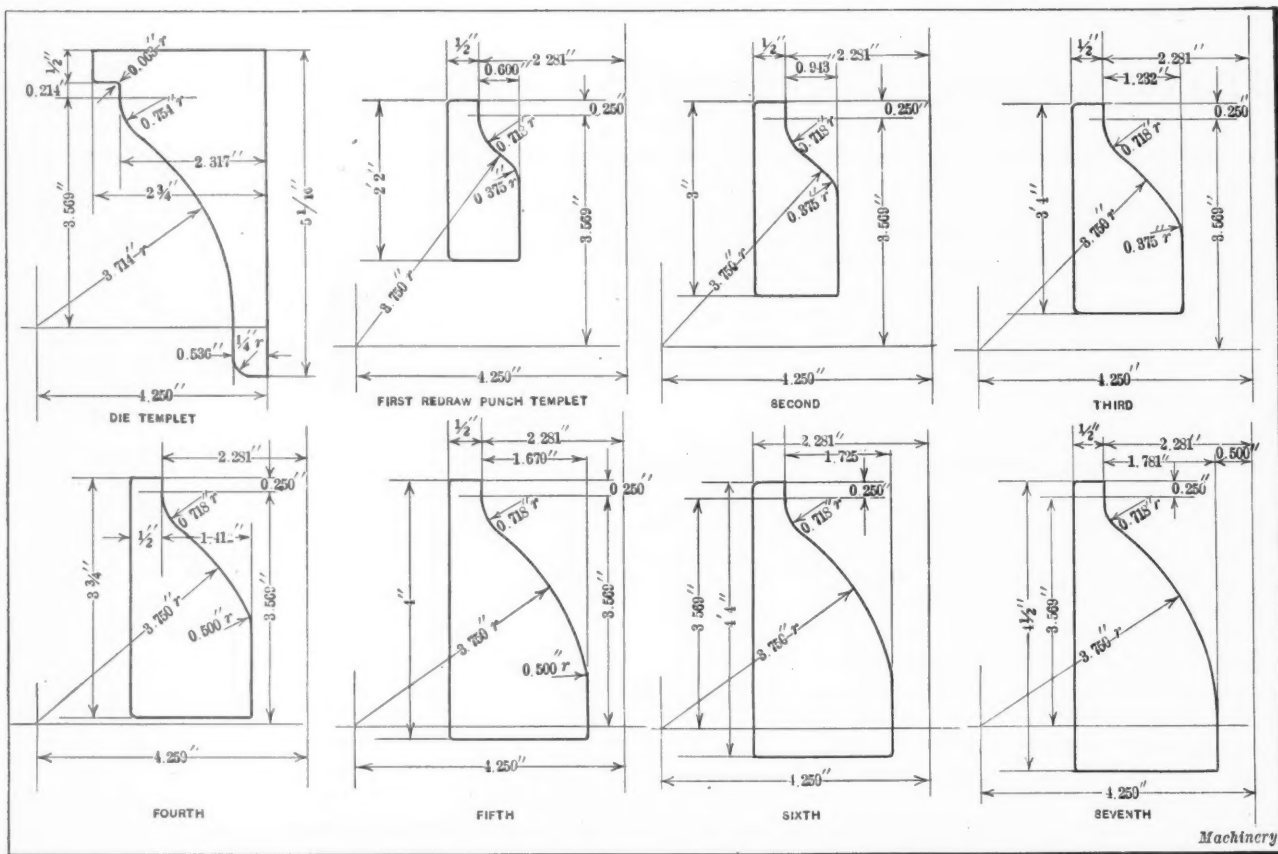
Fig. 2. Templets used in making and maintaining Dies shown in Fig. 5

can be readily drawn to a depth of 2.240 inches. Since this is the only operation in which the flanged section of the work is subjected to a drawing action, the drawn part beyond the flange should have an area equal to the area of all the remaining sections to be drawn in the succeeding operations.

In the first drawing operation, the cylindrical part, which is 4 9/16 inches in diameter, is finished, and in each subsequent drawing operation, a section adjacent to that finished in the preceding one is completed, the portion beyond the finished part retaining its cylindrical form. In no case is the reduction in diameter more than 20 per cent. The form of the work for each consecutive drawing operation is shown in Fig. 3.

In Fig. 2 is shown the set of templets used in making and maintaining the dies. These templets are made from 1/16-inch cold-rolled steel. The internal templet shown in the upper left-hand corner of the illustration serves for all the redraw die members. The blanking and drawing and the first redrawing operations are performed in a double-acting press.

In Fig. 5 is shown a cross-sectional view of each of the dies employed in the redrawing operations. All the dies used after the second redrawing operation are equipped with three spring-actuated pins or guides that stand just high enough to allow the flat flange of the work to rest on their upper ends when the end of the cylindrical part is in contact with the die. By this arrangement the stand is centralized and held perpendicular before the punch begins its descent. The last two dies shown require ejectors in the lower members, because the clearance between the punch and die at the cylindrical end is only equal to the thickness
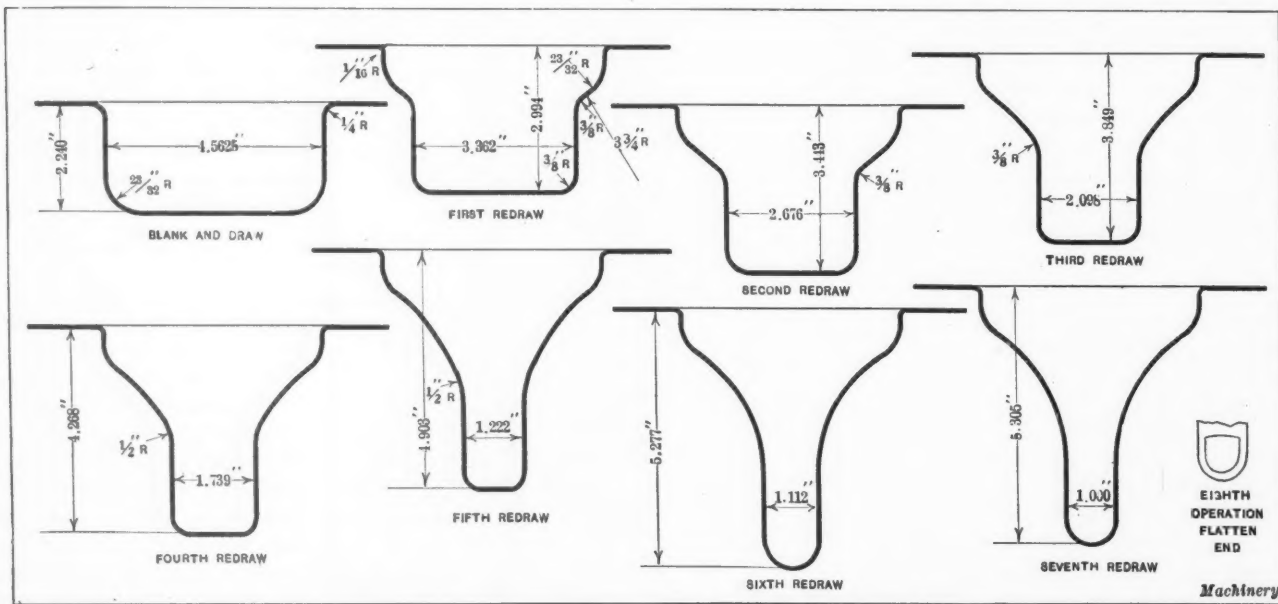
Fig. 3. Successive Drawing Operations in producing Electric Fan Base

of the metal being drawn. In the preceding redrawing operations, there is a difference of 0.020 inch plus the thickness of the metal between the two die members at this point.

In Fig. 4 is shown the completed stand. After the e i g h t h draw-press operation, in which the drawn end is flattened (see Fig. 3) the next operation is that of forming or flattening the other two sides of the head. This operation is performed on the flat sides of the spherical end in such a way that a bulging of the adjacent metal takes place. The die used is shown at A, Fig. 6. In the tenth operation, performed by the die shown at B, the bulge formed in the ninth operation is removed, so that the head is left smooth on all sides.

In the eleventh operation, the die shown at C, perforates the bolt-hole B, Fig. 4. This die is equipped with a horn which fits the inside of the head, and the swinging member attached to the base is brought into the supporting position after the work has been placed on the horn. The horn and swinging member are provided with holes in line with each other to receive the perforating punch. On the downward stroke of the press the punch first perforates the top side and then, continuing its way downward, perforates the opposite side which is in c o n t a c t with the s w i n g i n g member. By this arrangement the slug punched from the top side is made to act as a cutter on the opposite side.

The twelfth operation consists of forming the flange for the bolt-hole B, Fig. 4. The die used for this step, which is shown at D, Fig. 7, is provided with a collapsible form fitting the inside of the head. The collapsing member consists of three flat pieces which are shown spread out fan-shaped, the total thickness of the three pieces being 0.658 inch. Through this three-piece member is

Fig. 4. Details of the Completed Fan Base

Fig. 5. Drawing Dies employed in the Production of the Fan Stand Base
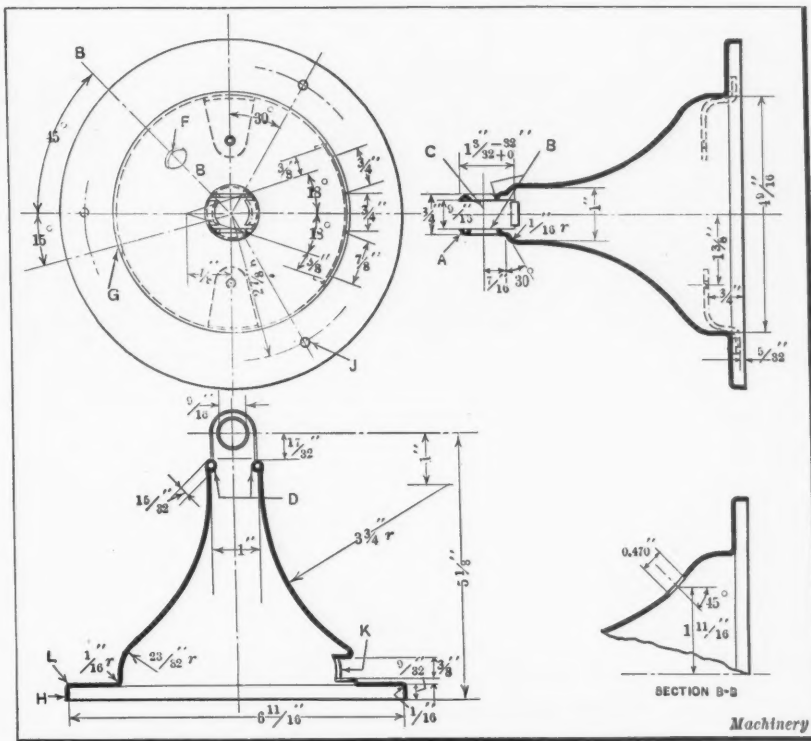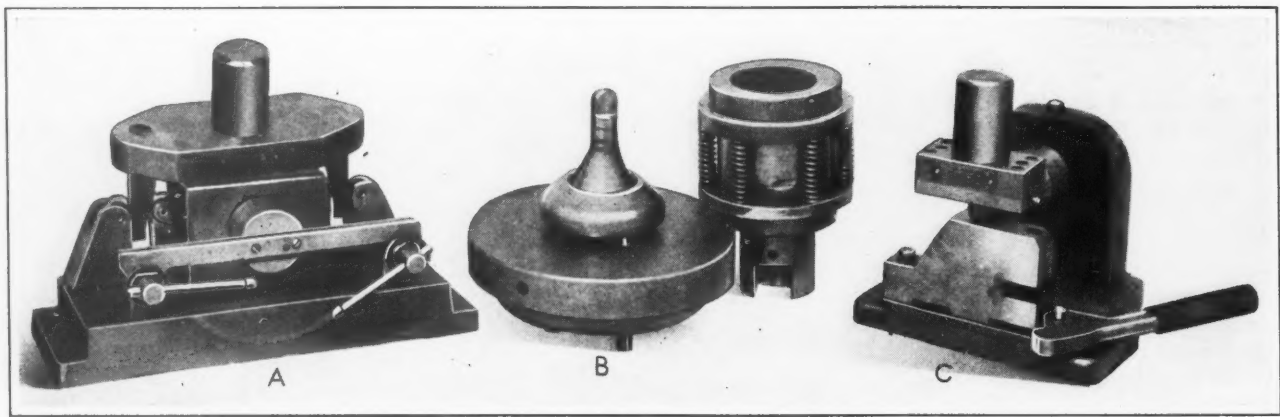
Fig. 6. (A) Die for flattening Sides of Head; (B) Die that removes Bulge formed by Die shown at A; (C) Bolt-hole Perforating Die

a hole having rounded edges which are brought in contact with the work at the point where the bolt-hole flange is formed. The two sides are formed simultaneously by an upper and a lower punch. The central piece of the collapsible member is withdrawn after the forming operation to allow the two side pieces to be removed. In the next operation the slot C, Fig. 4, is milled. A pair of saws, 1/32 inch thick, spaced 9/16 inch from outside to outside is used for this operation. These saws cut two slots and mill the inner edges of the formed bolt-hole flange.

The fourteenth operation is cutting out the central part

forating the hole F, Fig. 4, for the electric cord. In the eighteenth operation, the lead wire hole G is perforated, the die shown at I, Fig. 8, being employed for this purpose. From the illustration it will be noted that the die member that is attached to the press ram has a spring-actuated pressure pad which is designed to clamp the work to the lower die member before the perforating punch comes in contact with it.

In the nineteenth operation, the flange is formed as shown at L, Fig. 4, by the punch J, Fig. 9. After this operation, the work is placed on the die K, which perforates three holes
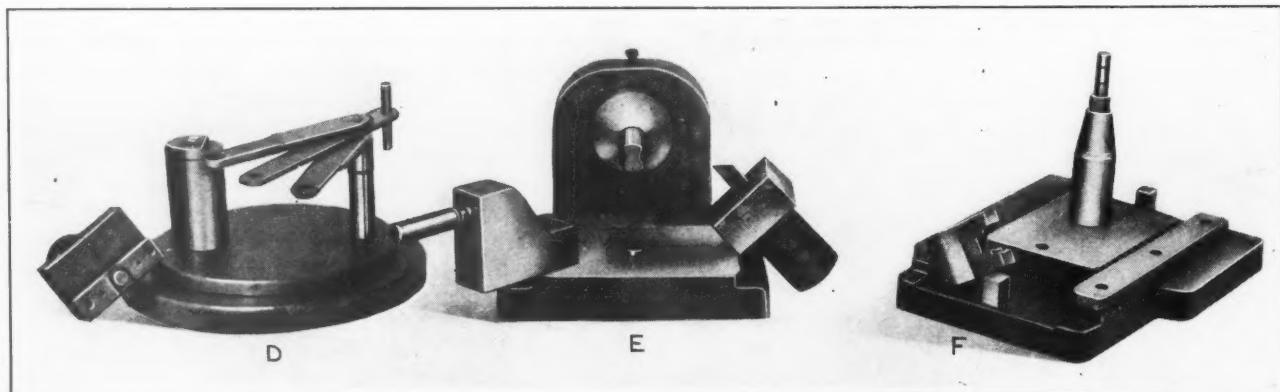
Fig. 7. (D) Bolt-hole Flange Forming Die; (E) Die for removing Metal left between Saw-Cuts; (F) Curling Die which forms Stops D, Fig. 4

of the head included between the two saw cuts. This is done by the die shown at E, Fig. 7. From the illustration it will be seen that this is also a horn die of simple construction. The next operation consists of curling the stops D, Fig. 4. The die shown at F in Fig. 7, which is used for this operation, curls both sides or stops simultaneously. The upper die member, which is attached to the ram of the press, is shown resting on the base of the lower die member.

In the sixteenth operation, the flange is trimmed to size by the die shown at G, Fig. 8. The seventeenth operation is performed by the die shown at H. This consists of per-

in the flange, one of which is shown at J, Fig. 4. A hole for the formed regulator slot K is perforated in the succeeding operation by the die shown at L, Fig. 9. The edges of this slot are next formed or bent inward to the shape indicated in Fig. 4, by the use of die M, Fig. 9.

In the production of the larger stand, shown at the extreme right in the heading illustration, practically the same methods and types of dies were employed. The method of calculating the blank area was also the same, except as regards the curved or irregular surface. As in the method described, a drawing was made of the work with the irregu-
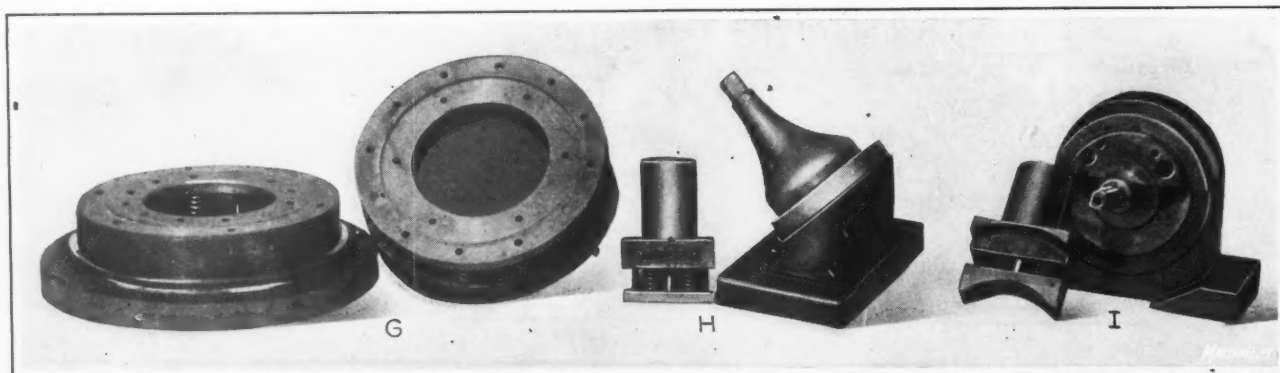
Fig. 8. (G) Flange Trimming Die; (H) Die used to perforate Hole F, Fig. 4; (I) Die for perforating Hole G, Fig. 4
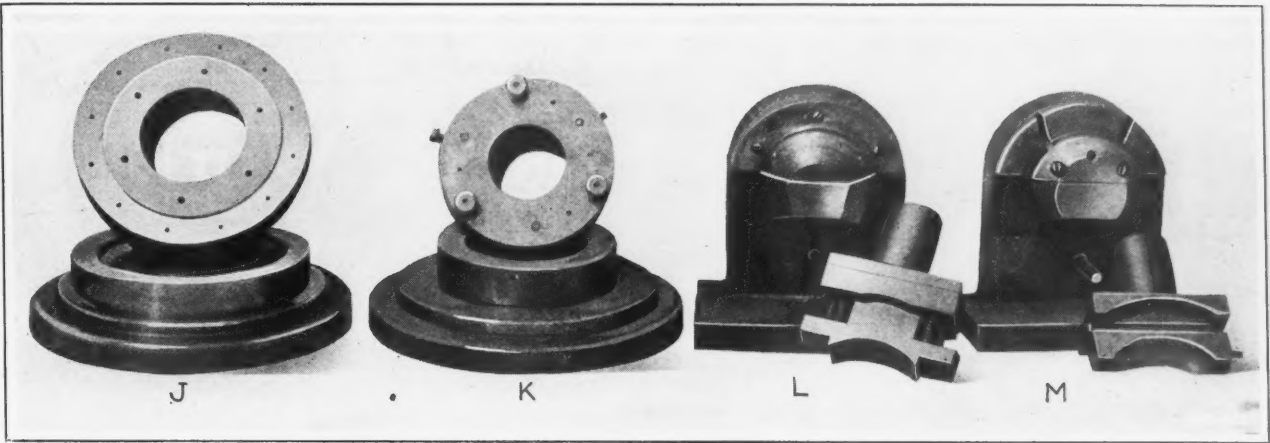
Fig. 9. (J) Flange-forming Die; (K) Perforating Die for Holes J, Fig. 4; (L) Die used to perforate Slot K, Fig. 4; (M) Die for bending in Edges of Slot K

lar surface divided into sections by horizontal lines. Each division in this case was considered as the frustum of a cone. The area of each section was obtained by multiplying the sum of the top and bottom diameters of each section by one-half the slant height. Obviously, this method gave practically the same results as that employed for the smaller stand.

The accuracy of these methods for determining the blank diameter is indicated by the fact that the ring trimmed from the edge of the flange in each case varies in width only from 1/32 inch at the thinnest place to 3/16 inch at the thickest. The trimming, as noted in the preceding description, is done before the edge is drawn or formed. An interesting feature of the redraw dies is that the anvils are made detachable to permit varying the length at this point, and also to facilitate making repairs.

* * *

Mexico imported in 1922 over 7250 passenger automobiles and nearly 1000 commercial trucks from the United States.

ADJUSTABLE CURVE FOR LAYING OUT SHEET-METAL WORK

By G. A. LUERS

A flexible steel curve provided with means for clamping so that it will retain its adjustment even when transferred from one piece of work to another or from one drawing board to another, is shown in the accompanying illustration. This curve is useful for pattern work, sheet-metal designing, and many lines of drafting-room work.

The flexible spline or curve A is made from sheet steel, and has six slotted strips B attached to it by angle pieces, such as shown by the detail view at C. One or more bolts like the one shown at D are used to clamp the slotted strips together in such a way as to give the spline the desired curve or contour. In the lower view, the spline is shown set for drawing or scribing an irregular curve. The position of the slotted strips is indicated by dotted lines E. In some cases, all the slotted strips are clamped together by one bolt instead of by four bolts as indicated in the illustration.
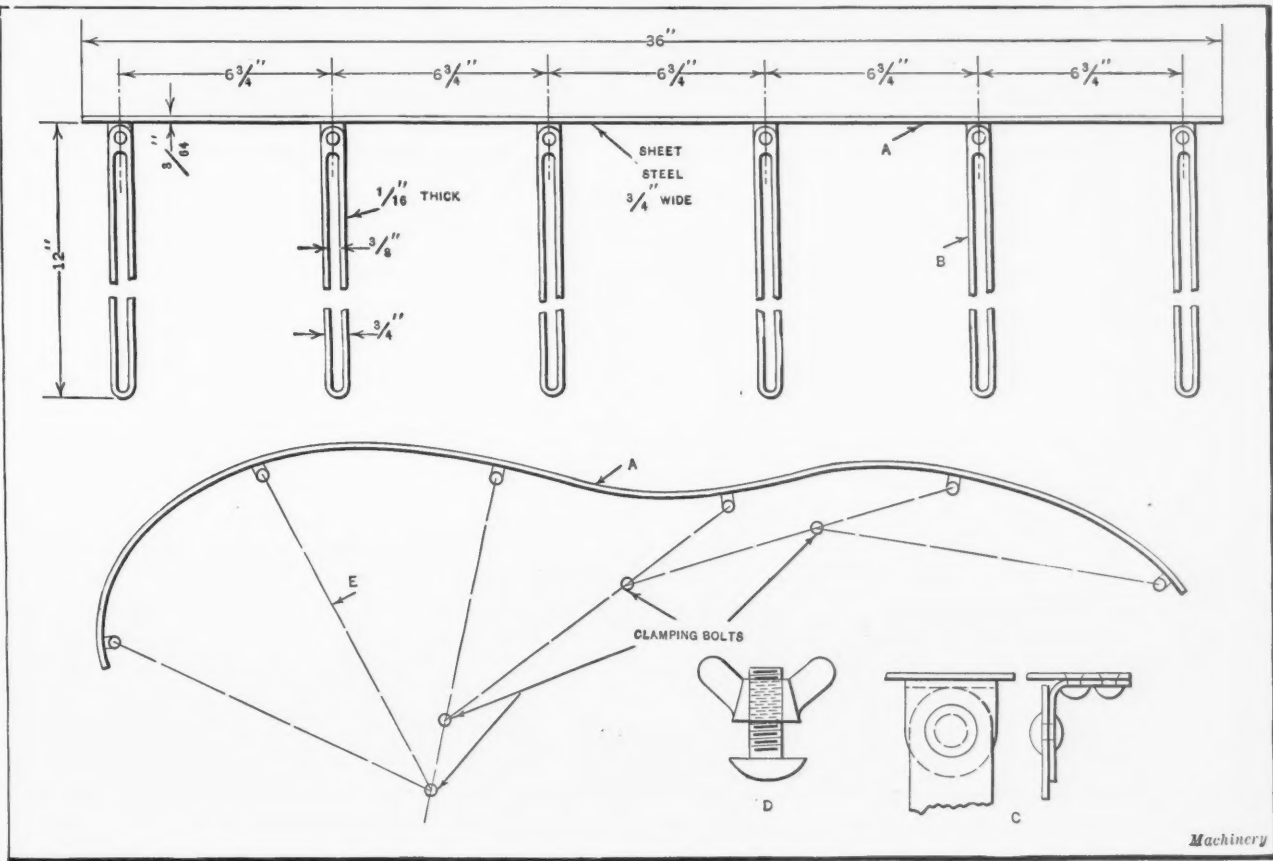
Flexible Steel Curve provided with Clamps for maintaining Setting
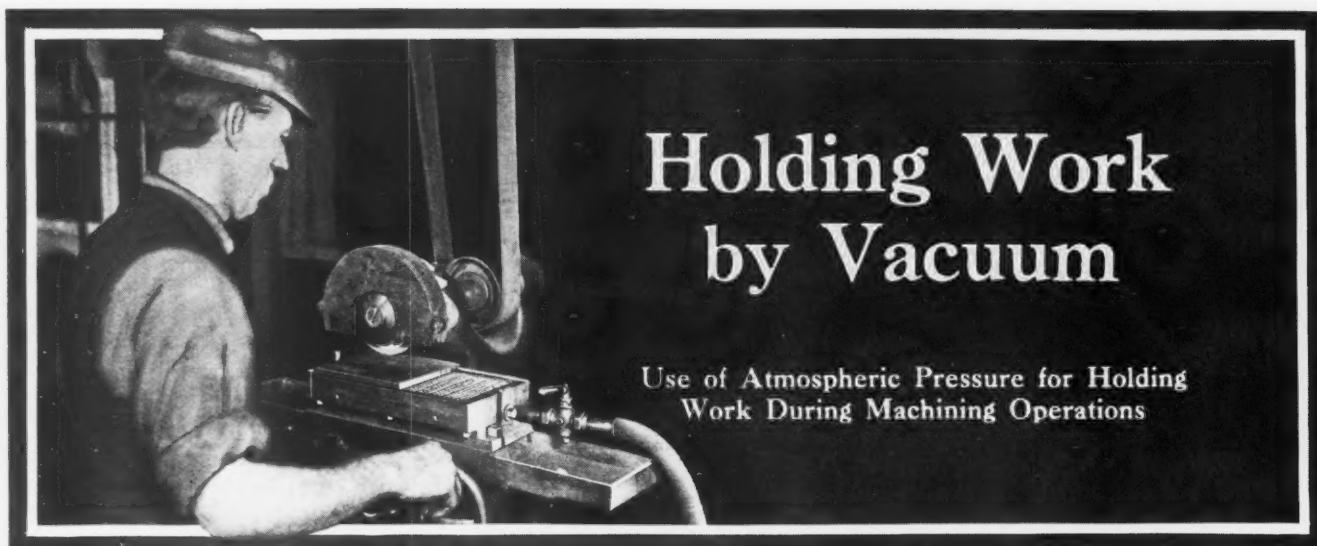
Holding Work by Vacuum

Use of Atmospheric Pressure for Holding Work During Machining Operations

By CHARLES O. HERB

ALUMINUM, brass, and other non-ferrous metal parts of small or frail construction are often machined under severe handicaps because of the difficulty of holding them. With thin aluminum castings, the use of clamps may result in distorting them to such an extent that they will not pass inspection, while with small brass pieces, production rates may be low because the lack of adequate holding means makes it impossible to load the machine with more than a few parts at one time. When small parts are made of iron or steel, they can be conveniently held on a magnetic chuck for quantity production. To provide for holding large quantities of small pieces made of either ferrous or non-ferrous metals, and non-metallic work, such as rubber, fabric, wood, or glass, the Crescent Pump Co., Detroit, Mich., after considerable experimenting, has developed a line of chucks that utilize vacuum for holding work. Several of these chucks and other vacuum equipment of particular interest to the machine shop will be described in this article.

Holding Power of Atmospheric Pressure

In each of these vacuum chucks there is a chamber which is made air-tight when the work is placed over it, either by the work covering the entire surface or by other means. A vacuum is then created by pumping all the air from the chamber, and as this is done, the work gradually becomes secured to the chuck by atmospheric pressure. As atmospheric pressure is approximately 14.7 pounds per square inch at sea level, a piece, say, 4 inches long by 1 inch wide (provided full vacuum has been created and practically the entire bottom of the piece is exposed to vacuum) will have a downward pressure of almost 60 pounds, tending to keep it from slipping on the chuck as the cutter is applied. When full vacuum has been created, the limit of holding power is obviously reached, and the pump then simply operates to maintain this

vacuum. Theoretically, when full vacuum has been obtained, it should be possible to stop the pump without the work becoming loose on the chuck.

The holding possibilities of vacuum equipment probably cannot be better illustrated than by the example in Fig. 1, where an ordinary stand or "old man" supporting a portable pneumatic drill that weighs about 90 pounds is shown being held to a horizontal ceiling beam by vacuum. The stand weighs 32 pounds, making a total of about 125 pounds supported in this way, and yet it was impossible to budge the set-up, even by attempting to shake the extended end of the stand column. The base of the drill stand or old man consists of two cup-shaped castings, between which is placed a large rubber gasket ¼ inch thick. This gasket makes the chamber formed by the inside cup-shaped casting air-tight on the I-beam. A hole drilled in the base end of the column serves as a passage through which the air in the chamber is drawn into the vacuum line. The outer base casting is only 8 inches in diameter, and yet this equipment is rated as having a holding power of 700 pounds.

Vacuum Chucks Installed on a Grinding Machine and Shaper

A grinding machine equipped with a vacuum chuck is shown in the heading illustration. The operation illustrated consists of grinding the sides of a number of flat stellite blades, this metal, of course, belonging to the non-ferrous class. The top of the chuck is covered with approximately 650 holes, 3/16 inch in diameter, which lead to a chamber in the chuck. A vacuum is created in the chamber by covering all the exposed holes with a square rubber gasket, and then sucking the air from the chamber through the hose attached to the right-hand end, this hose being connected to the main pump line. The rubber gasket was removed from the chuck at the time the photograph was taken, in order that the arrangement of the holes might be seen. In all cases where

Fig. 1. Holding a Heavy Portable Drill to an Overhead I-beam by Vacuum Equipment

the edges of the stellite blocks register over holes, the holes are made airtight by stuffing them with rubber corks. A rubber gasket is used only for the first cut, when the material is rough; in which case the bottom edges of the blocks must rest on rubber to make the chamber airtight.

Wet as well as dry grinding may be satisfactorily performed on machines equipped with vacuum chucks. Should water seep into the vacuum chamber, it would immediately be sucked into the vacuum line and discharged either into a water drain tank or into a large reservoir pipe near the pump, drainage means being also provided for this pipe. Fine dirt, which may be drawn into the vacuum line, is disposed of in the same manner. After an operation has been performed, the parts are released by simply closing the cock at the right of the chuck and permitting air to enter the vacuum chamber. An advantage especially pointed out by the manufacturer of these chucks is that cutters ground while held on them cannot become magnetized during the operation.

A second application is illustrated in Fig. 3, which shows a chuck attached to the table of a shaper, holding a flat iron casting. The top of this chuck has not as many holes as the chuck in the heading illustration, there being in this case but 81 holes, $\frac{1}{8}$ inch in diameter, arranged in two longitudinal and three transverse rows. The edges of the work rest on a thin rubber gasket, which raises the bottom of the casting about 1/16 inch above the chuck, and so produces an air chamber. When the air is withdrawn from this chamber, the atmospheric pressure causes the work to compress the gasket sufficiently to seal the chamber.

Typical Lathe Applications

An interesting vacuum chuck or arbor has been developed for holding the two halves of an automobile connecting-rod bearing while machining the outside surfaces in a lathe. Fig. 4 shows this arbor mounted in the spindle socket of a machine, one half of the bearing being seen in place on the arbor and the other half on the tool-slide. Although a
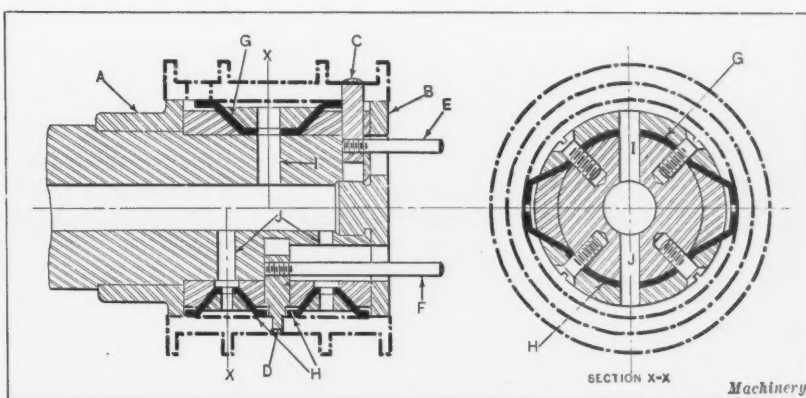
Fig. 2. Vacuum Chuck used on Lathes for holding the Two Halves of an Automobile Connecting-rod Bearing while machining the Outside Surfaces

single-point cutter is shown in the toolpost, all the surfaces are ordinarily finished simultaneously by employing a forming tool. The construction of this arbor is illustrated clearly in Fig. 2, in which the letters refer to the same parts as in Fig. 4.

As indicated by the heavy dot-and-dash lines, the work seats on the hardened rings A and B, which are of the same diameter as the bore of the bearing halves. One of the halves is located by means of sliding pin C, and the other by two sliding pins D. These pins engage oil-holes in the bearing boxes when they are moved outward radially by means of rods E and F. Rings A and B are separated by a cylindrical piece, which is machined to receive the rubber pad G on one side and two rubber pads H on the other, as well as the plates that secure these pads to the arbor. Before the work is slipped on the arbor, the edges of these pads extend beyond rings A and B, and so when the work is in place, they form small air-tight pockets under the work. The air is sucked from these pockets through vents I and J, thence through the hole at the center of the arbor shank and back through the spindle to the left-hand end of the headstock, where there is a connection to the pump line. The estimated pressure with which each bearing half is held on the chuck is about 55 pounds. Prior to opening the cock of the vacuum line, the pieces are held loosely on the arbor, and when the cock is opened the halves are pulled together as a vacuum is created.

Small gears designed with a solid web between the rim and the hub may be conveniently held on a vacuum chuck, as illustrated at A, Fig. 5, for turning or facing cuts or grinding operations. The gear is seated on the revolving part C, which is screwed into the tapped hole of part D, the latter being mounted on the spindle nose of the machine. Parts C and D rotate within the stationary part E, the latter having a connection to the vacuum line and ports through which the air drawn from chamber F is taken into the pump line. Chamber F is formed by mounting the work against the rubber sheet G, which is adequately supported between
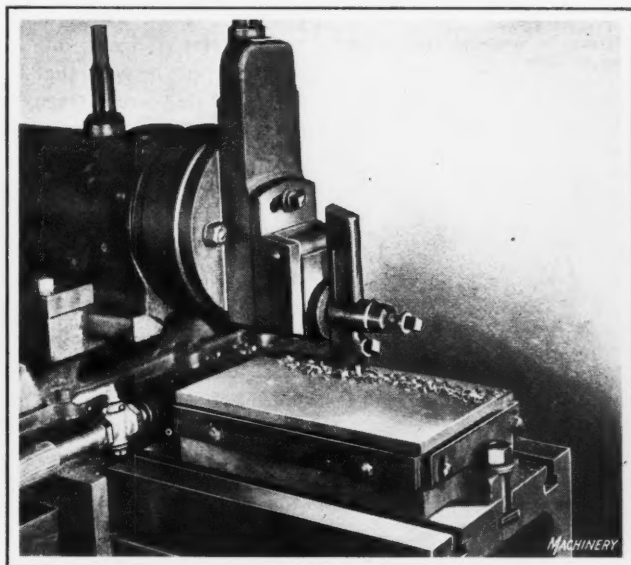
Fig. 3. Vacuum Chuck used on a Shaper Table
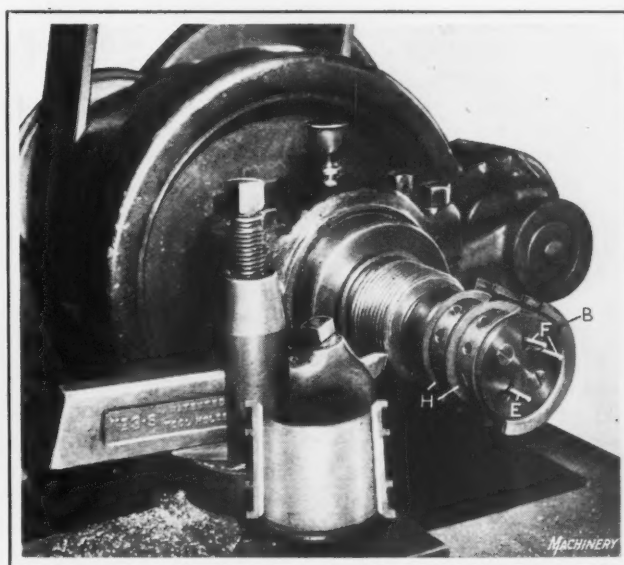
Fig. 4. Connecting-rod Bearing Chuck shown in Fig. 2
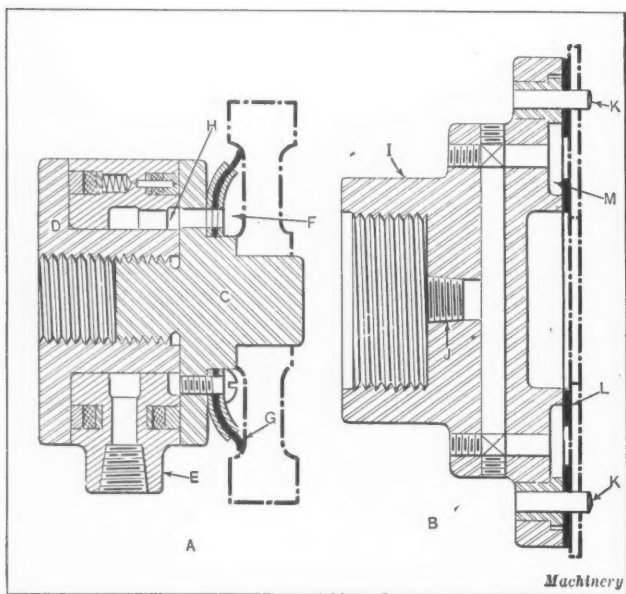
Fig. 5. Design of Chucks for holding Gears and Circular Plates on
Machines by Vacuum

two bent steel sheets. Recess *H* is continuous around
part *E*; consequently some part of the recess always regis-
ters with the hole in part *C*
leading to chamber *F*. Two
spring-actuated rings, with
palmetto packing between
them, are provided on each
side of part *E* to maintain a
certain amount of friction on
parts *C* and *D*, and thus in-
sure against air being drawn
into the vacuum line from
between the joints of these
rotating parts and part *E*.
The estimated pressure hold-
ing the gear in place is about
100 pounds.

A chuck of simple design for
holding thin circular plates
while turning the periphery
is illustrated at *B* in Fig. 5.
This chuck consists princi-
pally of part *I*, which is
mounted on the spindle nose
of the headstock and attached
to the vacuum line by a con-
nection at tapped hole *J*. The
work is centered on the
chuck by having several dowel-pins *K* register with holes
previously drilled. It rests against a rubber pad *L*, 1/32
inch thick, which has several holes cut through it to permit
the work to be held in place by the vacuum created in
chamber *M*. The long diametral hole in part *I* and the holes
that connect it to the vacuum chamber have their outer
ends plugged to prevent drawing air through them.

Other Vacuum Equipment

A vacuum equipment that functions as a vise for holding
automobile tire rims while chipping off the flash that is
formed in pressing them, is illustrated in Fig. 7. Before this
device was employed it was the practice to clamp the rim
in an ordinary bench vise for the operation, but this was
unsatisfactory, because the vise jaws would often distort the
rim, and the method of holding interfered with cleaning
the work properly. Considerable filing was frequently
necessary after chipping, and sometimes a milling opera-
tion, to produce a finish that would pass inspection. With
the vacuum vise, however, the rim does not become distorted,

and the method of holding the work permits the operation
to be completed satisfactorily in one step, with the result
that there is a considerable saving in the average chipping
time per tire rim.

It will be seen that the vise consists of a casting *A*, which
is cored out to receive two rubber pads *B* and retaining
blocks *C*. The rubber pads measure 6⅝ by 2⅛ inches. When
the work is placed on the vise, an air chamber is formed
between each block *C* and the rim, from which the air is
drawn through openings *D* and holes *E* to the vacuum line.
The vacuum line is connected to one of holes *E*, while the
other is plugged shut. The rubber pads are shown flanged,
but obviously they spring outward when the rim is removed.
It is claimed that in all this vacuum equipment there is little
wear on the rubber pads used to seal the vacuum chambers.

A small bench vise intended for holding parts by vacuum
during filing and similar operations is shown in Fig. 6. This
device is provided with only a few holes around which a
rubber or paper sealing gasket is placed for the work to
rest on. The same company has developed a device for
supporting the manufactured head of a rivet while applying
a riveting hammer to the other end when riveting parts
together. This device is held by vacuum to one of the plates
being riveted, the rivet-supporting head being attached to
an arm that can be readily swiveled to bring it over several
rivet holes. There is also a device for application to an
overhead crane, so as to con-
veniently lift parts about the
shop. With an equipment of
this sort having a chamber
diameter of 24 inches, loads
up to 6300 pounds can be
lifted. A hand-lifter of simi-
lar design having a chamber
2 inches in diameter may be
employed for lifting weights
up to 40 pounds. This hand-
lifter has proved useful in
placing and removing work
from power presses.

The "Roto-Piston" Dry Vacuum Pipe

In the "Roto-Piston" pump
built by the Crescent Pump
Co., for use with its vacuum
equipment, both the cylinder
or rotor case and the piston
revolve. However, the piston
does not reciprocate. Refer-
ring to Fig. 8, which shows
two sectional views of the
pump, it will be seen that the
rotor case *B* and its heads on each side are driven by
shaft *A*, the right-hand head being supported on a hollow

Fig. 6. Small Bench Vise in which Vacuum is employed for holding
Parts while chipping or filing

Fig. 7. Vise in which Vacuum is used for holding Automobile Tire
Rims while chipping away the Flash

crankshaft C. Contained within the rotor case and mounted on the hollow crankshaft is the piston or rotor D, which is driven by crankpins attached to the left-hand cover of the rotor case. By this method of driving the rotor is 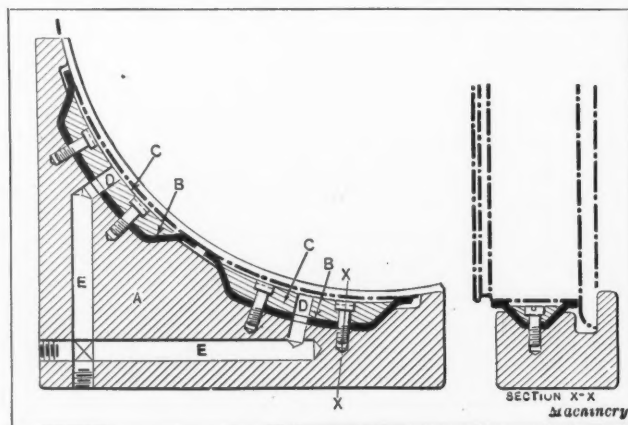given a rolling motion on the wall of its case, with the result that spaces E and F are constantly changing in volume from nothing to maximum and vice versa. When either space is at maximum, it forms a complete crescent, and it is from this feature that the company has taken its name.

During its operation, the pump sucks air through the hollow crankshaft C, which is connected to the line leading to the various vacuum chucks and other vacuum equipment about the shop. From the crankshaft the air is drawn through ports into rotor D, and then through port G into space E, from which it is forced out through port H as space F is diminished. Vane I is spring actuated sidewise against the heads and against the flat surface L on which it slides back and forth, thus automatically maintaining a seal between chambers E and F.

In the end sectional view, the maximum width of space between the rotor casing and the rotor is quite close to vane I; however, when the case and rotor have made some-

CONVENTION OF AMERICAN SOCIETY FOR STEEL TREATING

The fifth annual convention of the American Society for Steel Treating and the International Steel Exposition held under the auspices of the society will take place in Motor Square Garden, Pittsburg, Pa., during the week of October 8. A great number of papers will be presented during the five-day convention of the society, many of which have been secured from engineers abroad who have made special investigations or who have had unusual experience along certain lines in the heat-treatment field.

Last year the meeting and exposition of the society was held in Detroit, where it was visited by more than 20,000 people. For the exposition in Pittsburg 25 per cent more space is available than in Detroit, and the 50,000 square feet of exhibition space will be given over to a display of appliances and equipment for steel treating, exhibits of metals, and metal-working machinery. Much of the equipment at the exhibition will be in operation.

It is possible to obtain a reduction in fare amounting to a fare and a half for the round trip to Pittsburg for the

TOP SECTION　　　　　END SECTION
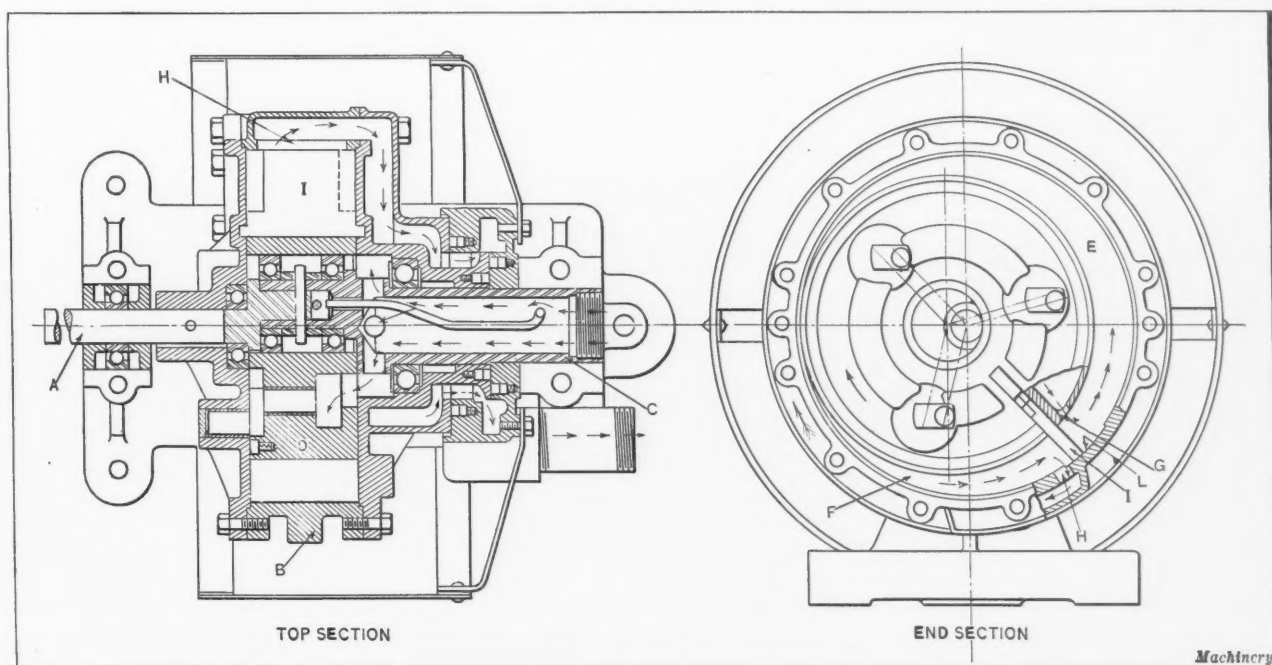
Fig. 8. Sectional Views of the Vacuum Pump used in Connection with the Equipment Described

what less than one-half a revolution, they will be practically touching at the vane. The claim is made that this pump constantly maintains a one-half inch vacuum. The pump has other applications than here described; in one automobile plant it is used for discharging paint into an overhead tank. In the piping between the pump and the equipment from which it draws air, there is located, as previously mentioned, a reservoir pipe usually about 6 inches in diameter and 6 feet long.

* * *

QUALITY STANDARDS FOR INDUSTRY

The voluntary establishment of standards of quality in the industries forms the subject of a pamphlet that has just been printed by the Fabricated Production Department of the Chamber of Commerce of the United States. The pamphlet points out that quality standards are essential in the commercial interchange of commodities beyond the stage of first-hand transactions, in which personal observation and opinion govern. Commercial progress is largely measured by the existence of quality standards, and commercial integrity is measured by strict adherence of the business world to these standards.

purpose of visiting this exposition; but in order to obtain the benefit of this reduced fare, it is necessary to write to the headquarters of the American Society for Steel Treating, 4600 Prospect Ave., Cleveland, Ohio, for a certificate for presentation when purchasing tickets.

* * *

EMPLOYMENT CONDITIONS IN ENGLAND

In England employment conditions remain bad, though the slight steady improvement that has been a feature for some months past is maintained. The greatest improvement is to be seen in the automobile and the electrical trades. Automobile and electrical workers are well employed in some districts, and the same may be said of workers in structural engineering and locomotive works. In marine engineering, employment on the northeast coast, as a result of the boilermakers' strike, is seriously affected. In Glasgow some of the locomotive builders and other works have had to suspend men, and similar reports come from other parts of Scotland. The number of registered unemployed in the engineering industry at the end of May was over 191,000, or 16.6 per cent of the total unemployment, as compared with 17 per cent at the end of April.

CALCULATING A TOOL ANGLE

By EDWARD HELLER

The draftsman or toolmaker is often confronted by the problem of finding the angle required on the cutting face of a tool that is to be used in machining the corners of a tapered hole of triangular, square, or other shape. The problem, as usually met with, is as follows: Given a hole of any number of sides (say six), with the half angle of each corner equal to D, as shown in the central view of the accompanying illustration. The taper of the hole is represented by the angle E. It is required to find the half angle D_1, as indicated in the view taken perpendicular to line C–C. Angle D_1 is actually the angle to which the work is machined, and is the same as the angle of the tool or broach that is used to form the corner of the tapered hole.
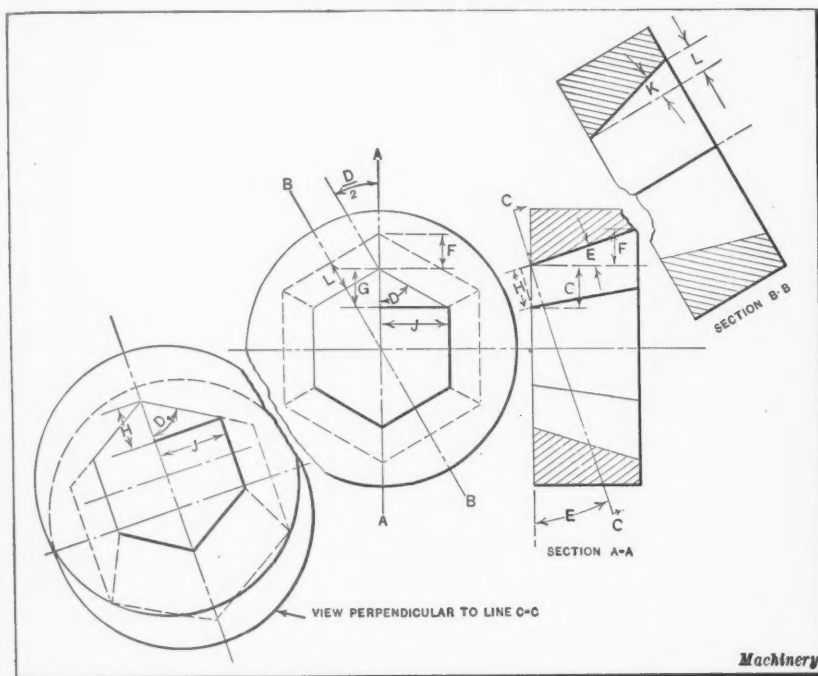
Diagram used in calculating Tool Angle

In the central view of the illustration,

$$\text{Tan } D = \frac{J}{G} \tag{1}$$

and in view C-C

$$\text{Tan } D_1 = \frac{J}{H} \tag{2}$$

Now referring to section A-A,

$$\text{Cos } E = \frac{H}{G}$$

and

$$H = G \cos E \tag{3}$$

Substituting the value of H given in Formula (3) in Formula (2), we obtain the equation

$$\text{Tan } D_1 = \frac{J}{G \cos E} \tag{4}$$

But

$$\frac{J}{G} = \tan D$$

Then substituting this value in Formula (4), we obtain the equation

$$\text{Tan } D_1 = \frac{\tan D}{\cos E} \tag{5}$$

It should be noted that tan D=1.00000 in the case of a square hole, where angle D is 45 degrees. For this case, Equation (5) becomes

$$\text{Tan } D_1 = \frac{1}{\cos E}$$

In some instances angle E is not given, angle K being given instead, as indicated in section B-B. In such a case, it is necessary to first find angle E in terms of some given values. Assuming that the length of the work is unity, we have the equation:

$$L = \tan K \quad \text{(See section } B\text{-}B) \tag{6}$$

and

$$F = \tan E \quad \text{(See section } A\text{-}A) \tag{7}$$

$$\frac{L}{F} = \cos \frac{D}{2} \quad \text{(see central view)} \tag{8}$$

Substituting the values given in Equation (6) and (7) in Equation (8), we obtain the following:

$$\frac{\tan K}{\tan E} = \cos \frac{D}{2}$$

and

$$\text{Tan } E = \frac{\tan K}{\cos (D \div 2)}$$

The angle D always equals $\dfrac{N-2}{N} \times 90$

where N=number of sides in tapered hole.

As an example, let it be assumed that the angle D_1 of a five-sided tapered hole is required, the taper of the hole or angle K being 10 degrees.

Now,

$$D = \frac{3}{5} \times 90 = 54 \text{ degrees} \quad \text{and} \quad \frac{D}{2} = 27 \text{ degrees}$$

Then

$$\text{Tan } E = \frac{\tan 10 \text{ degrees}}{\cos 27 \text{ degrees}} = \frac{0.17633}{0.89101} = 0.19801$$

and

$$E = 11 \text{ degrees } 12 \text{ minutes}$$

Now

$$\text{Tan } D_1 = \frac{\tan 54 \text{ degrees}}{\cos 11 \text{ deg. } 12 \text{ min.}} = \frac{1.3764}{0.98096} = 1.4023$$

and

$$D_1 = 54 \text{ degrees } 31 \text{ minutes}$$

The included angle of the cutting end of the tool=$2 \times D_1$ or 109 degrees 2 minutes.

* * *

INDUSTRIAL CONDITIONS IN GERMANY

In a report on German industrial conditions, assistant trade commissioner F. W. Allport states that the present production in the German machine industry is only about one-half of what it was in pre-war days. A great many organizations of manufacturers have been formed in the machine industries, and at the end of 1922 there were not less than 143 manufacturers' associations in this field, comprising concerns employing a total of from 500,000 to 600,000 men—90 per cent of the entire number engaged in the machine-building industry. Shortage of material has caused a great deal of trouble of late, and among other difficulties are mentioned shortage of capital, due to the depression of German currency, the eight-hour day, high overtime wages, labor disputes, injudicious methods of taxation, and import restrictions. At the present time working hours are reduced, rather than the number of men employed, and many of the plants operate only two or three days a week. It is stated that the conditions in the machine tool field are somewhat better than those in the general machinery field.

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MACHINERY'S DATA SHEETS Nos. 17 and 18

MEASURING SCREW THREADS

MEASURING SCREW THREADS BY THREE-WIRE METHOD

The effective or pitch diameter of a screw thread may be measured very accurately by means of some form of micrometer and three wires of equal diameter. This method is extensively used in checking the accuracy of threaded plug gages and other precision screw threads. Two of the wires are placed in contact with the thread on one side and the third wire in a position diametrically opposite (as illustrated by the diagrams, which represent a sharp V-thread and the U. S. standard thread), and the dimension over the wires is determined by means of a micrometer.

The accuracy of the pitch diameter may be determined when the correct micrometer reading for wires of a given size is known. The micrometer reading for a U. S. standard thread can be determined by the following rule: Multiply the constant 1.5155 by the pitch of the thread (equal to 1 ÷ number of threads per inch); subtract the product from the screw, and then add to the difference three times the diameter of the wires used; the result equals the micrometer reading if the pitch diameter of the thread is correct. If the actual micrometer measurement over the wires differs from the calculated results, there is an error equal to the difference.
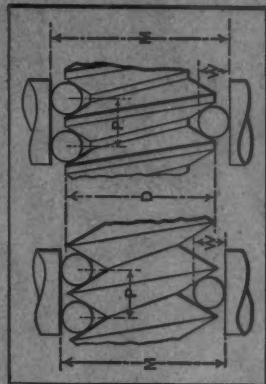
The foregoing rule is expressed in the following as a formula, and additional formulas are given for different standard threads. In these formulas, M = the micrometer reading or measurement over the wires (see illustration); D = the standard outside diameter of the screw; P = the pitch of the thread; and W = the diameter of the wires used.

The formula given for the U. S. standard thread may also be used for the French A. S. M. E. standard and the International standard, the pitch in millimeters, in the latter case, being changed to pitch in inches before using the formula.

Example.—A screw 1¼ inches in diameter and having twelve threads per inch of the U. S. standard form, is to be measured by the three-wire method; the wires are 0.070 inch in diameter. What is the correct micrometer reading?

$$M = 1\tfrac{1}{4} - \left(1.5155 \times \frac{1}{12}\right) + (3 \times 0.070)$$

= 1.5837 inch.

If the micrometer reading is 1.591 inches instead, it indicates that the pitch diameter of the screw is too large. The amount of the error is the difference between the actual micrometer reading of the screw and the theoretical reading as found from the formula. In this case, then, 1.591 − 1.5837 = 0.0073 inch, the amount the pitch diameter is too large. The outside diameter may be correct, or 1¼ inches, but the flat on the top of the thread may be incorrect so as to account for the difference.

U. S. Standard Thread $M = D − 1.5155 × P + 3W$

Whitworth Thread $M = D − 1.6008 × P + 3.1657W$

British Association $M = D − 1.7363 × P + 3.4829W$

Lowenherz $M = D − 1.75 × P + 3.2359W$

Sharp V-thread $M = D − 1.732 × P + 3W$

CUT HERE

MEASURING SCREW THREADS

LIMITS FOR DIAMETERS OF WIRES

When wires are used in conjunction with a micrometer for measuring screw threads, the minimum wire diameter must be such that the wires extend beyond the top of the thread in order to prevent the micrometer from bearing on the threads instead of on the wires, and the maximum limit must be such that the wires bear on the sides of the thread and not on the corners or top edges.

The following formulas for determining wire diameters do not give the extreme theoretical limits but the smallest and largest sizes that are practicable. The maximum and minimum diameters given in the accompanying table are based on these formulas.

DIAMETERS OF WIRES FOR MEASURING U. S. STANDARD AND WHITWORTH SCREW THREADS

Thds. per Inch	Pitch, Inch	Wire Diameters for U. S. Standard Threads			Wire Diameters for Whitworth Standard Threads		
		Max.	Min.	Pitch-line Contact	Max.	Min.	Pitch-line Contact
4	0.2500	0.2250	0.1400	0.1443	0.1900	0.1350	0.1409
4 1/2	0.2222	0.2000	0.1244	0.1283	0.1689	0.1200	0.1253
5	0.2000	0.1800	0.1120	0.1155	0.1520	0.1080	0.1127
5 1/2	0.1818	0.1636	0.1018	0.1050	0.1382	0.0982	0.1025
6	0.1667	0.1500	0.0933	0.0962	0.1267	0.0900	0.0939
7	0.1428	0.1286	0.0800	0.0825	0.1086	0.0771	0.0805
8	0.1250	0.1125	0.0700	0.0722	0.0950	0.0675	0.0705
9	0.1111	0.1000	0.0622	0.0641	0.0844	0.0600	0.0626
10	0.1000	0.0900	0.0560	0.0577	0.0760	0.0540	0.0564
11	0.0909	0.0818	0.0509	0.0525	0.0691	0.0491	0.0512
12	0.0833	0.0750	0.0467	0.0481	0.0633	0.0450	0.0470
13	0.0769	0.0692	0.0431	0.0444	0.0585	0.0415	0.0434
14	0.0714	0.0643	0.0400	0.0412	0.0543	0.0386	0.0403
16	0.0625	0.0562	0.0350	0.0361	0.0475	0.0337	0.0352
18	0.0555	0.0500	0.0311	0.0321	0.0422	0.0300	0.0313
20	0.0500	0.0450	0.0280	0.0289	0.0380	0.0270	0.0282
22	0.0454	0.0409	0.0254	0.0262	0.0345	0.0245	0.0256
24	0.0417	0.0375	0.0233	0.0240	0.0317	0.0225	0.0235
28	0.0357	0.0321	0.0200	0.0206	0.0271	0.0193	0.0201
32	0.0312	0.0281	0.0175	0.0180	0.0237	0.0169	0.0176
36	0.0278	0.0250	0.0156	0.0160	0.0211	0.0150	0.0156
40	0.0250	0.0225	0.0140	0.0144	0.0190	0.0135	0.0141

U. S. Standard
{ Smallest wire diameter = 0.56 × pitch
Largest wire diameter = 0.90 × pitch
Diameter for pitch-line contact = 0.57735 × pitch

Whitworth
{ Smallest wire diameter = 0.54 × pitch
Largest wire diameter = 0.76 × pitch
Diameter for pitch-line contact = 0.56368 × pitch

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, August 16

THE conditions in the engineering industries are not so good as they were at the beginning of the year, and few manufacturers are receiving a satisfactory number of orders. There are exceptions, notably in the light motor car industry, structural engineering, and electric machinery. Currency depreciation has again eliminated the Continent from active buying of engineering products. The machine tool industry, however, appears to have passed the worst period, and though, as in other industries, the more optimistic hopes of the beginning of the year have not been realized, there is a slight improvement to be noticed if the industry is considered as a whole. It is reasonable to suppose that the grouping of the railways will bring improvements generally in railway shop practice, and though the first attention has naturally been in the direction of locomotives and rolling stock, railway shop equipment requirements are likely to place demands on several of the makers of heavier machine tools in the very near future.

In the standard lines, there appears to be most business in the Birmingham area, and one well-known maker of turret lathes has not only disposed of a large stock during the past month or two, but has over a hundred new machines in process of manufacture, and these are being sold as fast as they can be completed. The automobile industry and marine engine builders are at present the most prominent among machine tool customers. Another machine tool firm is building a large number of heavy planers, and finds the demand good for wheel lathes as well as boring mills. In this particular shop a large number of men have been taken on, and enough work is in hand to maintain full employment until October.

Makers of punching and shearing machines appear more active, and grinding machines are generally in better demand. More than one machine tool concern owes a certain amount of activity to products out of the field usually covered. Several machine tool firms are undertaking the manufacture of special automatic machinery. Machine tool works are naturally well equipped for this class of work, and the production of machines for piano action parts and the automatic wrapping of loaves of bread may be cited as examples of the class of work that is being undertaken.

In the Glasgow area, one firm has a number of heavy lathes on order for the Continent. Heavy-duty vertical drilling and boring machines have been shipped from this district, and good inquiries are reported for horizontal drilling and boring machines and radial drilling machines.

The demand for small tools remains fairly steady. Some very large orders for files have recently been booked with Sheffield concerns on behalf of the British Admiralty. The Egyptian State Railways and Australia and South Africa are also mentioned as very good markets for Sheffield files.

Overseas Trade in Machine Tools

The returns for the export trade in machine tools during June show a reduction from the previous month. The tonnage fell from 1490 (in May) to 1055, the corresponding values being £153,855 and £110,769. Imports rose from 282 to 406 tons, the value being £53,403 instead of £38,403. The value per ton of exports remained steady at about £105, and that of imports at about £135. The average pre-war figures for value per ton were: Exports £61; imports £97. Lathes and drilling machines figured largely in the exports for June, and lathes and grinding machines represented the greatest values in imports. The value per ton of exported lathes was only £95 whereas imported grinding machines averaged £232 per ton.

General Machine-building Activities

In the majority of the machine-building industries the best that can be said is that the results of the past six months are better than those for the last six months in 1922, but locomotive orders are now few and far between, and many of the big contracts for rolling stock are nearly completed. Electrical shops continue to be active on heavy equipment, especially for the Colonies, where several railway electrification schemes are in progress.

Structural shops are perhaps more regularly employed than any other of the engineering branches, and prices for structural work are now on a cost basis, with a promise of a reasonable profit if the activity continues. Textile machinery makers continue to be fairly busy on account of both home and export orders; and there are signs of increased buying for South America and the Continent.

The marked increase of work in the building trades is reflected in some of the light foundries. Shops specializing in laundry and refrigerating machinery are receiving orders quite regularly. Steam-engine builders and transmission manufacturers in the Yorkshire districts expect little improvement until the cotton, woolen and worsted industries, flour milling and paper making show signs of revival. In these industries even repairs are not put in hand until necessity compels. South Africa and the Colonies generally are taking a fair share of mining and crushing machinery.

The Automobile Industry

In the motor-car industry, business is better than usual at this time of the year. One plant in Coventry has been dispatching 500 engines a week for assembly in a light car that has gained wide popularity during the last twelve months; 1,400 men are employed in three shifts of 8 hours each. New works extensions are expected to make place for another 500 men next year. Special machinery of unique design is being made, and the system of continuous or "line" production is being perfected. The demand for large cars is small, but motorcycle works remain busy. Motorcycle shipments for India are growing. The Albion Motor Co., Ltd., Glasgow, is producing a new vehicle on the caterpillar principle, for countries where the roads are very bad.

Marine Diesel Engines

The Clyde has taken a lead in the matter of the marine Diesel engines, and a large variety of types are now being constructed, which is responsible for a considerable activity which sooner or later must affect machine tool makers. One of the best equipped plants in the country is the Diesel engine shops at Harland & Wolff's extensive new establishment at Govan, where there are some highly interesting tools, and competition is certain sooner or later to call for equipment elsewhere of an equal quality. The engines passing into service at the present time form the first phase of the application of the oil engine to sea conditions.

THE REAL MEASURE OF WAGES

The survey of earnings, employment and working hours made by the National Industrial Conference Board, covering over 600,000 wage earners in twenty-three different industries, shows definitely that average wages today, as compared with the average cost of living, are considerably higher than they were before the war.

The real measure of wages is their purchasing power. The figures collected by the National Industrial Conference Board show that the average hourly earnings of the 600,000 wage earners considered, were, in the spring of 1923, 36 per cent above the purchasing power of the hourly earnings in July, 1914. As the working hours had decreased approximately 9 per cent, the purchasing power of the weekly earnings was 33 per cent above the pre-war level.

This increase in earnings as compared with the cost of living means that the average wage earner is able to consume one-third more than in 1914. As wages are paid out of goods manufactured—that is, out of production—it means also that improved machinery and better working systems have made it possible to produce more than before the war; because only by increased production could the higher wages be paid with a reduction in the number of working hours.

This is something for both workers and labor leaders to consider. Industrial development in ten years has made possible a reduction of nearly 10 per cent in working hours and an increase of over 30 per cent in the purchasing power of wages. That is a very creditable showing for a nine-year period, and labor leaders may well pause to consider whether it is not better to permit this gradual upward trend to continue steadily and peacefully, than to interrupt it with serious disturbances in the form of strikes, or by such rules covering working conditions as limit production and decrease efficiency. The industrial machine has done well during the past decade. Only the obstructionists would throw sand in the gears.

* * *

MORE DATA ON COST REDUCTION

Several other examples of the savings effected in automobile and other plants by using modern machine tools have come to our attention since the editorial in August MACHINERY was published:

An automobile manufacturer formerly employed ten machines and eight men for the machining operations on the cylinders of his engine. The original equipment, which cost $25,000, was recently replaced by two modern semi-automatic machines costing $15,000, and with these two machines instead of ten, and two men instead of eight, the same production was obtained.

In another case an automobile manufacturer employed eight machines of the standard type, working two shifts and requiring sixteen operators to obtain a production of fifty pieces in twenty-two hours. The machine and tool equipment cost $26,000, and it was replaced by a single-purpose machine occupying considerably less floor space than the eight machines formerly used. For this machine only four operators were required, working one shift. The cost of the single-purpose machine was $11,000, and the production sixty-three pieces in nine hours.

In still another case two machines and two men performed a boring operation on twenty-five pieces per hour, while a new semi-automatic turret lathe, with special tooling equipment which required but one operator, produced thirty-seven pieces per hour. The cost of the turret lathe was $2300, and the direct saving $1800 per year.

In small tools, operated in connection with modern machine tool equipment, similar improvements have been made. A tap of special construction used on a high-speed tapping machine has produced 70,000 tapped holes without grinding; and as a tap of this type can generally be reground from ten to twelve times it probably will tap from 700,000 to 800,000 holes before it must be scrapped. This may be a record performance, but in everyday practice one manufacturer, in tapping steel, uses a No. 6-32 tap of this type which regularly taps from 35,000 to 40,000 holes between regrindings, the total number of holes tapped by one tap being about 400,000.

Most machine shops are still operated with some inefficient machine tool equipment, which does not include the marked improvements that have been made during the last five years, and except in the case of a few well standardized machines, the output could be greatly increased by the use of the more modern types. Even in the so-called "standard" types of machine tools—lathes, drilling machines, milling machines, and planers—such great improvements have been made recently in their strength, cutting capacity and ease of operation, that much greater production can be obtained from them, simply because the latest machines can be operated at higher speeds and with heavier feeds—that is, more efficiently.

* * *

JUSTICE TO OUR RAILROADS

The fixed policy of many newspapers to assail the management of our railroads especially entitles the railroads to credit when it is due. Everyone who is practically familiar with them knows that during the last two years wonderful progress has been made in their improvement and rehabilitation, compared not only with war conditions, but with those existing previously. Since January, 1922, some 250,000 freight cars have been ordered, of which about 150,000 have been delivered. During the same period more than 4000 locomotives have been ordered, about one-half of which have been delivered up to date. A shortage of 67,000 freight cars has been turned into a surplus of 75,000 in less than three years. During recent months the railroads have broken all records in the handling of freight, and yet there is a net surplus of freight cars in good repair and immediately available for service. In the week ended July 28, 1,041,044 freight cars were loaded with revenue freight, the largest number for any one week in the history of the country. In October, 1920, nearly as great a freight movement was recorded, but then there was a shortage of over 67,000 freight cars.

The railroads also have been buying a considerable amount of machine tool equipment during the past year, indicating an increasing appreciation of the need for modern machine tools in the railroad shops, and the percentage of locomotives and cars awaiting repairs is unusually small at the present time. Perfection will always be unattainable in railroad operation as in every other industry under the sun; but a closer approach is possible under the management of men who have been working toward it for years along practical lines, than through any of the methods advocated primarily to catch votes.

The Mechanical Education of a Draftsman

By DONALD A. NEVIN, Tool Engineer, Landis Machine Co., Waynesboro, Pa.

THE term draftsman is used in the industries to refer to almost any position from tracer up to that of mechanical engineer. In the following, the writer refers to mechanical draftsmen who have had some training in technical or manual training schools, or who have spent one or more years at the drafting board in making detail or assembly drawings for mechanisms of machinery, in general, and especially for machine tools, special metal-working machinery and equipment, as well as for punches and dies, milling fixtures, drill jigs, milling cutters, and gages. It is the object of this article to point out some of the deficiencies in the training of young men who are ambitious to become first-class draftsmen and designers of machinery and tools. The writer bases his statements upon an experience of many years in charge of a great number of men of this class in both small and large industries, engaged in the manufacture of diversified lines of products.

The most common deficiency among younger draftsmen is the lack of a thorough mechanical education. This is not due so much to the lack of opportunities for instruction as it is to failure on the part of the young men to take advantage of the valuable opportunities that are offered them for acquiring additional education in the evening schools and by reading mechanical books and journals. In nearly all cities, the ambitious young man may attend night school and receive both theoretical and practical instruction at a small cost. Many a draftsman starts as a blue-print boy or tracer, and seems to think that he can learn the trade simply by performing the work that is assigned to him during the working hours of the day. He overlooks the great value of night study and of acquiring additional knowledge through reading. Without study outside of working hours, no man can become a really good draftsman and designer, and certainly he can never become a mechanical engineer. For this he needs not only to acquire a great deal of theoretical knowledge, but must also have the practical experience that can be obtained only through actual work in the factory. Without this experience he will lack initiative and resourcefulness.

The value of practical experience cannot be over-emphasized. A general knowledge of machinery can be obtained from a study of books dealing with the subject, from a review of catalogues, and from watching the machines in operation. But to become a really good designer, the draftsman should actually operate machines and perform practical work. It is seldom that a designer can thoroughly appreciate all the conditions that meet the operator, unless he has done this. The man who has actually handled a machine tool knows how to arrange the knobs and handles conveniently; he appreciates the effort required to shift a belt; and he knows instinctively what will produce chatter in machining. The proper proportion of levers, arms of pulleys and gears, and numerous other machine parts are more easily determined by the man who has had an opportunity to be in intimate contact with a variety of machinery; and the draftsmen and designers who have this knowledge will find it much easier to produce creditable work. The ability to invent and design mechanical mechanisms is seldom found in a designer whose training has not included practical experience in the machine shop, although there are many good designers who can produce acceptable designs from sketches that outline and suggest the necessary mechanical movements and the means for obtaining them.

The Need for Knowledge of Mathematics

On the other hand, those designers and draftsmen who have had shop training in many cases lack a knowledge of mathematics. Sometimes a knowledge of some of the processes of arithmetic is lacking, and frequently the draftsman's knowledge of trigonometry and geometry is deficient. Many draftsmen or designers overlook the need for a thorough knowledge of the principles of theoretical mechanics, and therefore are limited in the application of the means for obtaining the desired ends in designing a machine.

A thorough knowledge of such branches of mathematics and theoretical mechanics as are needed by the ordinary draftsman and designer may be obtained from books now available to mechanical students, which have been prepared especially with the needs of the practical man in view. This literature is very complete and within the reach of all. Books on mathematics, machine design, toolmaking, gearing, and practically every other subject that relates to the mechanical field are easily obtained; and engineering handbooks, which are partially reference books and partially text-books, should be a part of the equipment of every draftsman. There is, however, too much indifference on the part of draftsmen and designers in regard to study. They do not take advantage of the opportunities offered to them.

Many draftsmen and designers are not sufficiently familiar with the available technical literature to be able to make practical use of it. The information available in these books has been collected by practical men engaged in every line of work, and should be of the greatest value to other young men in the same line of industrial work. For example, an engineer, who during a period of fifteen or twenty years collected valuable data on automatic screw machine practice, contributed these data from time to time to the mechanical press, and thereby stimulated others to contribute similar information on the same subject. All this material appearing in book form represents a collection of the best practice of many men in many shops.

Waste of Time Due to Lack of Knowledge of Contents of Handbooks

Many needless calculations are made in the shop and drafting-room, not because reference books are not avail-

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The most common deficiency among younger draftsmen is the lack of a thorough mechanical education. This is not due so much to the lack of opportunity for instruction as it is to failure on the part of the young men of today to take advantage of the valuable opportunities that are offered them for acquiring additional education in the evening schools and by reading mechanical books and journals. Many a draftsman who starts as a tracer seems to think that he can learn the trade simply by performing the work given to him during the working hours of the day. He overlooks the great value of night study and of acquiring additional knowledge through reading. Unless he does some studying outside of working hours, no man can expect to become a good draftsman and designer.

able, but because the owners of the books are not familiar with the contents of the handbooks in their possession, and do not realize that they could take figures directly out of the handbook instead of spending time in needless calculation. Every draftsman, designer, and toolmaker should look through his handbooks occasionally in order to become thoroughly familiar with the many convenient tables and the vast amount of information on different subjects that they contain. He will find that a good handbook contains conversion factors, convenient multipliers, tables of circumferences, areas, lengths of arcs, tables for spacing holes and circles, tables for figuring tapers, etc., which would prove great time-savers if they were made use of.

Sometimes it may prove of value to the user of a handbook to provide a simplified index for his own individual needs. When he finds that there are certain subjects to which he often refers, he might make notes in pencil on the fly-leaf in the front of the book of those particular subjects. Care should be taken to exclude all indexing of subjects that are not referred to very often, because the regular index is more convenient for general reference; but this auxiliary index for quick reference may aid the owner to find without delay those particular tables in the book to which he most frequently refers. If a man refers very frequently to certain tables in the handbook, he will, of course, become so familiar with their location in the book that he will need no index at all.

There is very little truth in the assertion often heard: "I can figure this out in less time than I can find it in a handbook." That is very seldom the case. Furthermore, the figures given in handbooks have been carefully checked. Their accuracy can be more safely depended upon than the accuracy of the worker's own calculations.

Needless calculations are also frequently made to determine angles and lines by trigonometry, when great accuracy is not required. In many cases, a lay-out to an enlarged scale would give angles and lengths of lines as accurately as would be needed for the purpose, and the answer could be measured by a protractor or scale in a fraction of the time required for the trigonometrical calculations.

A thorough knowledge of such branches of mathematics and theoretical mechanics as are needed by the ordinary draftsman and designer may be obtained from books now available to mechanical students, which have been prepared especially with the needs of the practical man in view. This literature is very complete and within the reach of all. Books on mathematics, machine design, toolmaking, gearing, and practically every other subject relating to the mechanical field are easily obtained, and engineering handbooks, which are partially reference books and partially text-books, should be included in the equipment of every draftsman.

Home Study for the Machinist Apprentice

As the best draftsmen and designers in the general machinery and machine tool field are generally drawn from the apprentices who have completed part or all of a shop apprenticeship, a few words on the home study necessary for a shop apprentice may be of value. Frequently the apprentice is started in the tool-crib, where he has an unusual opportunity to learn, provided he has an inquiring mind. Here he can become familiar with the uses of every tool and appliance that he hands out, and then at night he can study elementary mechanical books, catalogues, and advertisements in mechanical journals, and thus obtain a great amount of information relating to general tool equipment. The average mechanic, and especially the apprentice, often overlooks the fact that the advertisements in mechanical journals contain a vast amount of information on shop practice of great value. The advertisements change from month to month, and by studying these regularly, the reader becomes familiar, not only with the varied equipment that is available, but also with the makers of equipment for different classes of work.

The apprentice should also purchase a number of elementary books on machine shop practice, shop arithmetic, gearing, and elementary machine design. If he expects to be able to work independently, he must also become familiar with patternmaking and foundry practice—branches of work with which he may not come in direct practical contact in the shop. The apprentice who studies at home has an opportunity of studying mechanical problems that have come up during the day and of acquiring all the knowledge on these subjects that is available in mechanical books. He may also reverse the process, and use what opportunities he may have to observe in the shop the operation of machines and the application of methods about which he has studied in his books the night before. The really ambitious young man can acquire a complete encyclopedia on machine shop work if he so wishes, in which he will find information on all the types of machinery and tools ordinarily used in machine shops and on all methods generally employed.

After he has acquired an elementary knowledge of mechanical subjects, the ambitious young man will go further in his studies. He will begin to read books on methods of production, efficiency, factory management and systems, because he will look forward to the day when he will not be a mere cog in a machine, but one of the men who lead instead of follow. On the other hand, if he has inventive ability and desires to become a machine designer, he will obtain some of the books available on machine design, tooling equipment, and advanced practical mathematics. The subjects chosen should be those that are in close contact with the work on which the student is engaged or that cover the line of engineering that he intends to make his life work. Publishers of technical books can usually advise as to what particular books would be most suitable for a young man to study, provided he will state his experience and the line of work for which he is endeavoring to fit himself.

The Toolmaker Apprentice

The apprentice who intends to become a toolmaker and tool designer should endeavor to become familiar with every phase of work required in toolmaking practice. For example, if the young man serves his apprenticeship with a firm engaged in building machine tools, he may have little opportunity to become familiar with punches and dies during his apprentice period. A knowledge of punch and die work, however, is very important to any man who wishes to be a toolmaker, and although he may not specialize in it, he should acquire all the knowledge on this subject that he can obtain by reading the books available on punch and die design. A good toolmaker also needs a fair knowledge of mathematics. He certainly should understand the elements of trigonometry, and have a thorough grounding in all the methods of arithmetic. A knowledge of these subjects is easily obtained from the simplified treatises available today. A toolmaker equipped with a knowledge of mathematics is more valuable than one who cannot perform his own calculations; he can command higher pay and is in line for promotion.

While it is not necessary for a tool and die maker to be proficient in drafting, he should know how to make sketches, and should be able to lay out a simple design on paper, if called upon to do so. A good toolmaker should have studied a book on mechanical drawing, and should know enough about that subject so that he can make use of all the methods ordinarily employed in drafting practice. It is the ability to do a little more than the job actually requires that makes it possible to secure advancement.

A Course of Study for Draftsmen and Designers

Perhaps the best way for the draftsman to acquire shop practice is to pass through a regular apprenticeship, but it is also possible for him to obtain sufficient practical experience by working as a helper in a shop while studying drafting and the other necessary subjects. Certainly he should not try to enter the drafting-room until he has had at least a year's experience in the shop.

Many student draftsmen make the mistake of undertaking the more difficult studies before they have laid a solid foundation. No attempt should be made to study algebra, geometry, trigonometry, and machine design until all the elements of arithmetic have been thoroughly mastered. After that, is it well to study the purpose of various machine tools and the principles involved in different production methods, and to obtain a general knowledge of mechanical movements. When this has been done, a more advanced course in mathematics and machine design will prove not only more helpful, but also more interesting.

If the young man will study at home while he is working in the shop, he will undoubtedly have a much better chance of obtaining a position in the engineering field that will support him immediately, than he would have after having attended an engineering school for four or five years without having any practical experience. A correspondence school course in designing and mechanical engineering should not be taken unless the student is simultaneously employed in a mechanical line of work, because it is only by carrying on the theoretical and the practical work side by side that real success can be expected; but it is quite possible to learn to draw from studying the books and courses provided on mechanical drawing, which are usually very thorough. In studying drawing, it is of great value to obtain blueprints of detail drawings and assemblies. It is also of great value to study the illustrations in mechanical journals, as the instruction thus obtained supplements that given in the books on drawing.

In addition to studying mechanical drawing, the young man fitting himself to become a draftsman and designer should study some book that will teach him the elements of algebra and trigonometry, and elementary treatise on theoretical mechanics, the strength of materials and machine design, patternmaking, and molding. He must also learn something about the materials that are used in engineering design, and he will find that there are good books available on iron and steel and on the heat-treatment of steel. Then, in these days of specialization, he may devote himself to some particular line of engineering, and will have to choose books dealing with that particular field.

Tool Designers and Production Engineers

Should he desire to become a tool designer or tool equipment engineer, the subjects that he should study, in addition to those already mentioned, are toolmaking practice, punches and dies, automatic screw machine cams and tools, drilling jigs, milling fixtures, cutters, grinding, gear-cutting, broaching, welding, boring, shaping, and planing.

If he expects to fit himself for a production engineer, he needs to include books on time study, wage systems, bonus systems, shop systems, and the routing of work. A good production engineer should be especially familiar with the design of cams for automatic screw machines, dial and roller feeds on punch presses, combination and multiple dies, the design of milling cutters and other cutting tools, and the use of special machinery.

In these days, when developments follow each other so rapidly, even the successful engineer must remain a student in order to keep pace with the rapid advancement that is being made in the mechanical industries. Fortunately, the mechanical journals provide him with a review of the advances made, so that he can follow the progress by spending a few minutes daily with a journal in his field.

PRODUCTION POSSIBILITIES OF THE POWER PRESS

By A. EYLES

Many articles formerly spun from sheet metal are now produced faster, better, and more economically in the power press, and numerous parts that were forged or cast have also been replaced by pressed parts that are fully as satisfactory and much cheaper. Some idea of the output of modern sheet-metal working machinery may be gained from the following figures taken from actual practice:

One type of automatic press has a capacity for producing brass caps for fuse plugs from No. 30 gage strip brass at the rate of over 9000 pieces per hour. Another press is capable of producing seamless drinking cups at the rate of over 2100 per hour. This machine is run at about 9 strokes per minute and averages 532 operations per hour, drawing four cups at a time. Another press is capable of cutting washers from strips of hard-rolled steel 1/16 inch thick at the rate of 540 washers per minute.

With an automatic double seaming machine it is possible to simultaneously double-seam the top and bottom to the body of square and irregular shaped sheet-metal boxes up to 8 inches wide and 12 inches high at the rate of 10,000 ends per day. An automatic inclined press will produce over 50,000 circular sheet-metal stampings per day, and it is possible for one workman to attend to two or three machines at the same time. Power press work is usually a matter of long runs, thousands or hundreds of thousands of pieces being required, and it is because of this fact that it is profitable to make the dies. Yet in some shops where there is but a small amount of manufacturing done on a large scale, it is often necessary to do work of this kind in small quantities.

Punches and dies for cutting tin plate require grinding approximately once for every 100,000 cuts, while tools used with sheet steel must be resharpened once for every 10,000 or 15,000 cuts. The reason for this great difference is that there is no scale on tin plate, as it is removed prior to the tinning process. With light brass or copper articles, it is not always necessary to harden the punch, and this considerably reduces the cost. No hard-and-fast rules can be laid down relative to hardening punches; sometimes it is not convenient to harden them on account of the shape of the article to be produced.

* * *

CATALOGUES SENT ABROAD

A number of foreign countries impose duties on catalogues and other sales literature. It frequently happens that when a catalogue is sent to some country where a duty is imposed, the addressee finds it necessary to go through all the ordinary custom house red tape that is required in connection with a large shipment, and in addition he is expected to pay the duty assessed and possibly a fee to a custom house broker who attends to the matter. The Department of Commerce states that it has happened that catalogues have cost the foreign addressee $5 or more. This obviously does not put the prospective customer in a suitable frame of mind for buying, even though it is true that his own government is responsible for the folly of assessing duty on trade information.

In order to assist the American business man in handling his foreign advertising matter and catalogues, the Foreign Tariff Division of the Bureau of Foreign and Domestic Commerce, has in course of preparation a series of bulletins describing in detail the restrictions imposed in various countries of the world. The list of this series is Trade Information Bulletin No. 122, entitled "Shipment of Samples and Advertising Matter to the British Empire." Copies of this bulletin may be obtained by addressing the Foreign Tariffs Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.
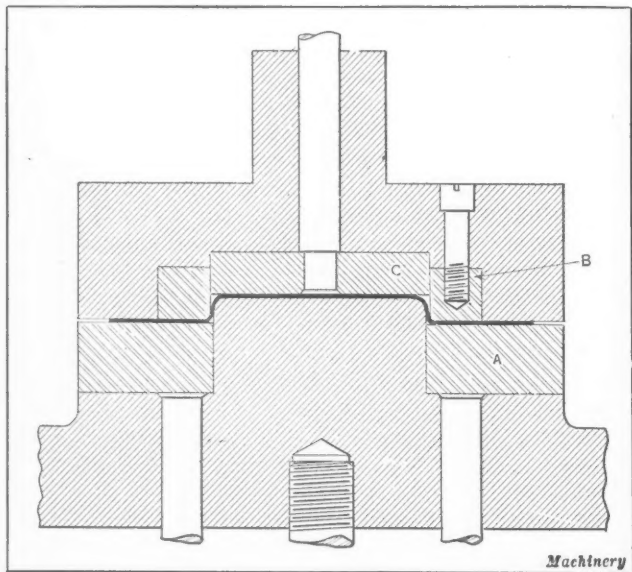
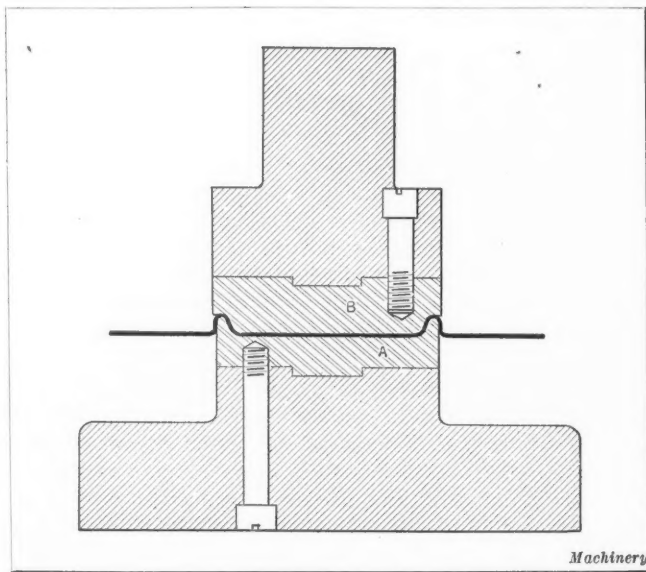Fig. 1. Preliminary Drawing Operation on the Bottom of a Metal Coffee-grinder

Fig. 2. Operation in which the Raised Portion of the Bottom of the Coffee-grinder is inverted

Dies for Producing a Square Part

By J. BINGHAM, President, The Bingham Stamping & Tool Co., Toledo, Ohio

A NUMBER of interesting dies are used in manufacturing the bottom of a square coffee-grinder and in assembling this part to the body of the grinder. The square shape, of course, makes the operations far more difficult than if the part were round. No. 20 gage material is used for this part, which is about 4 inches square and ¾ inch deep when completed. The blanking die has no unusual features in its design, and for that reason is not illustrated.

The blank is taken to a press equipped with draw-pins, a rubber buffer, and the plain drawing die illustrated in Fig. 1, on which it is drawn to the shape of the heavy full line, both the flange and raised portion being square. and having rounded corners. The die-block is made of cast iron, and has a hardened and ground tool-steel part A by means of which the blank is pressed against the punch face while it is drawn, part A being actuated by the draw-pins and the rubber buffer. The punch is also an iron casting, and has hardened and ground inserted facings B. After an operation is completed, the work is forced from the punch by the knock-out rod and pad C at its lower end. The work, of

course, is forced from the die, in the event that it adheres to the latter, through the functioning of the rubber buffer and the draw-pins.

In the next operation the piece is beaded in the die shown in Fig. 2. Block A is of an outside diameter that permits the work to be slipped over it. Then, when the punch descends on the downward stroke of the ram, the major portion of the raised section of the part is inverted by face B, as indicated by the heavy line. If the flange on the work were not so long, it would be possible to accomplish this and the preceding operation at the same time. The die-block and punch are made of cast iron, while faces A and B are made of tool steel, and are hardened and ground.

Forming and Trimming Operations

The next step in the production of the bottom of the coffee-grinder is performed on a press equipped with the die shown in Fig. 3. This die is also used in connection with a rubber buffer and draw-pins. The die-block is made of cast iron, and provided with hardened and ground tool steel parts A, B, and C. The punch is also made of cast iron, and has
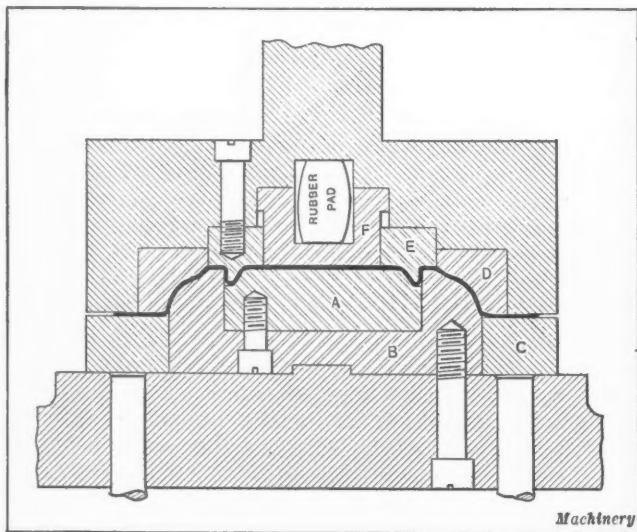

Fig. 3. Forming Punch and Die of Unusual Construction necessitated by the Square Shape of the Work
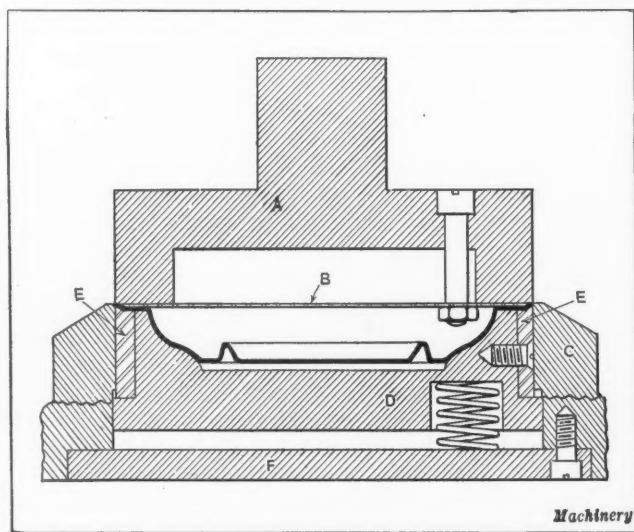

Fig. 4. Die for trimming the Flange of the Work and slightly curling up the Edges
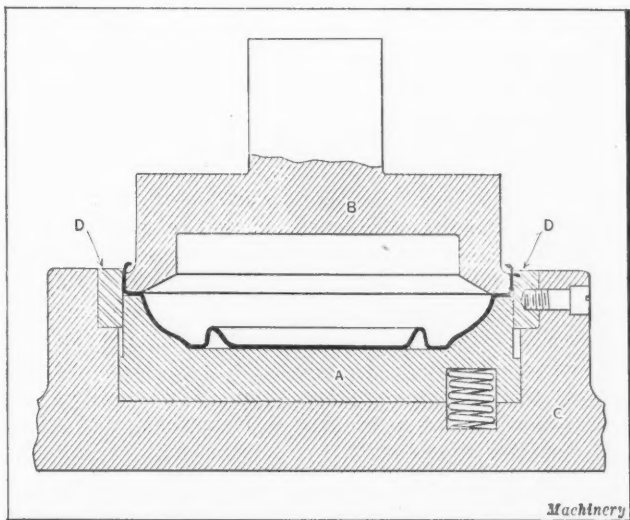
Fig. 5. Bending back the Flange preparatory to curling the Edge

Fig. 6. Operation in which the Edge on Each of the Four Sides is curled

tool-steel parts D, E and F. Prior to the descent of the punch, part C is in a raised position, its upper surface being in alignment with the top surface of parts A and B. Then as the punch descends, the blank is held securely between the face of the punch and the die part C, and is drawn to the shape illustrated. Knock-out F advances slightly ahead of the other punch members, owing to the action of the rubber pad, and thus serves to hold the blank on die part A.

The work is forced from the punch at the completion of the operation through the action of the knock-out F, and it is lifted from the die members as the draw-pins again raise part C to its normal position. If one die part were used, instead of parts A and B, it would be necessary to mill a recess in the face to form the inverted bead. The double construction makes the parts far easier to machine, and thus results in a considerable saving in time and money. In addition, member A can be replaced as it becomes worn without requiring replacement of part B.

The die equipment illustrated in Fig. 4 is employed for trimming the flange and at the same time slightly turning up the edges all around to facilitate a succeeding operation. Punch A is made of tool steel, and there is a sheet B of tool steel fastened to its face by means of machine screws. These screws pass through accurate holes in the sheet, and serve to hold it in the correct position relative to the die. The work is trimmed as punch A passes the top edge of die member C, sheet B functioning at the end of the stroke to turn up the edges, as already mentioned. The work is
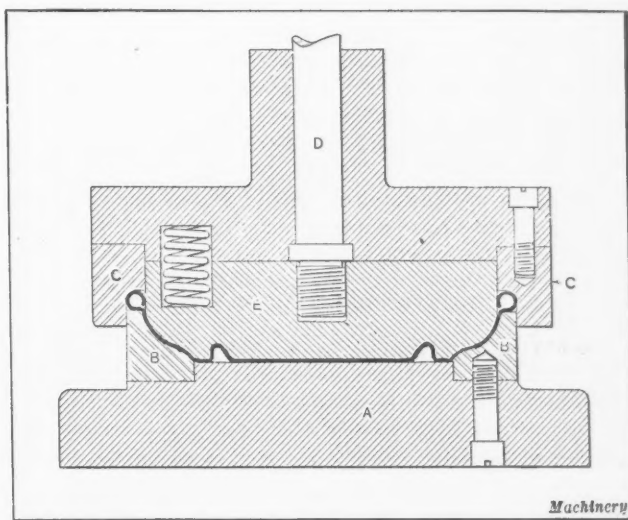
properly located for the operation by die part D, which is machined to suit the contour of the work.

Part D is raised somewhat at the time the punch comes in contact with it through the action of coil springs placed in counterbored holes in its lower side. It is forced downward as the punch descends, and when the punch rises on the upward stroke of the ram, it is again lifted by the coil springs. By means of this construction the work is forced from the die. Part D is made of cast iron, and has a tool-steel plate E set on each of its four sides. The upper section of die member C is made of tool steel, and the lower part of wrought iron, the two parts being welded together. Plate F is inserted in the bottom of die member C to hold the part D and its springs in the die.

Bending back the Flange and Curling it

The next operation, which consists in bending back the flange, is performed with the die illustrated in Fig. 5. It will be seen that this die is designed along the same lines as the one just described. The work is placed in die member A, which, previous to the descent of the punch, is held in a raised position by the coil springs shown, its top edge being in a line with the top of die-block C and the inserted pieces D. Part A is made of cast iron, while punch B is made of tool steel and hollowed out to reduce its weight.

The final operation on the piece prior to assembling consists of curling or wiring the lower edge. This is accomplished by means of the punch and die shown in Fig. 6.

The work is correctly located in the die by the four tool-steel pieces B, which are attached to the die-block A. When the punch descends, knock-out E, which is advanced ahead of the other punch members by the action of several coil springs between it and the punch proper, is the first to come in contact with the work. At this point knock-out E remains stationary while the other punch parts continue to descend, thus exerting an increasing pressure on the work as the coil springs are compressed, and holding the work in a fixed position.

The edge of the work is curled as parts C on the punch slide over parts B on the die. It will be obvious that there
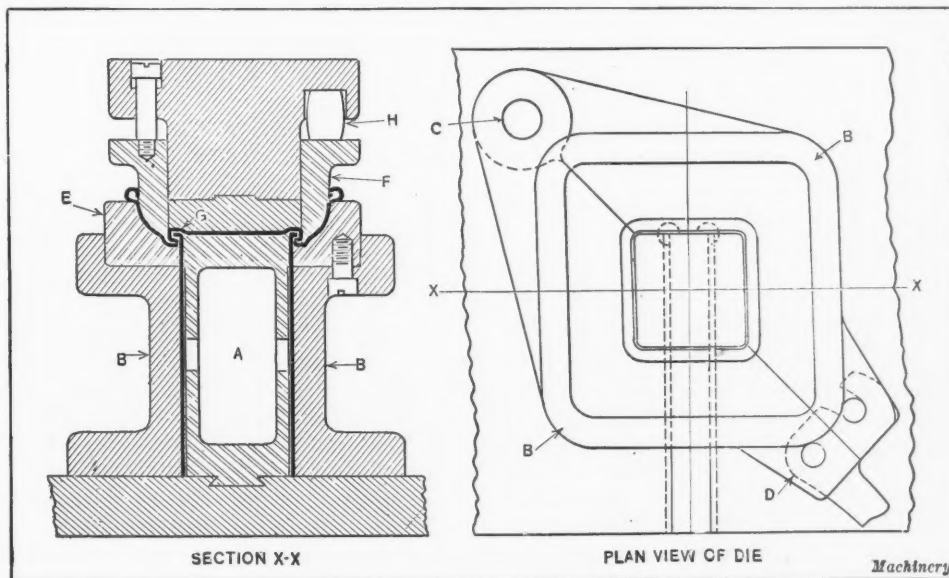

SECTION X-X PLAN VIEW OF DIE

Fig. 7. Hinged Die employed in assembling the Bottom to the Grinder Body

must be an accurate fit between parts B and C. This curling operation is considerably facilitated by the fact that the edge of the work is slightly curved in the previous operation. On the return stroke of the punch, knock-out E remains stationary as parts C slide from parts B, and thus holds the work in the die, from which it can be readily removed as the punch reaches the end of its upward stroke. Should the operation of the knock-out fail to remove the work from the punch members, it is forced out when rod D is operated at the end of the stroke.

Assembly of the Coffee-grinder

The assembly of the bottom to the body of the grinder is performed by means of the punch and die shown in Fig. 7; this illustration shows a section through the punch and die members, and a plan view of the die. It will be apparent that the body of the grinder is first placed on the upright die member A, after which jaws B, which swivel on pin C, are brought together and locked by lever D. The body is approximately 4 inches square. The bottom of the grinder is then seated on die parts E, which are attached to the top of the jaws.

Two different punches are used with this die, the second of which is shown. The first punch is solid and has an angular face that begins bending the edge of the bottom at G, so that it can be completely bent around the flange of the grinder body by means of the second punch, shown in the illustration. Member F is provided with rubber pads H to advance it ahead of the punch proper and the face attached to the punch.

* * *

BROACHING VULCANIZED FIBER

By GEORGE E. HODGES

Some of the various methods employed in machining vulcanized fiber were described in June MACHINERY on page 781. Although not dealt with in that article, broaching has been found to be a very satisfactory and economical method of machining certain parts made from vulcanized fiber. The writer believes that a few pointers regarding the broaching process will be of value to those engaged in the manufacture of fiber products.

One of the most interesting applications of the broaching process is in the production of timing rings for automotive igniting systems. Practically all the large manufacturers who make timing rings are now using broaches to accurately size the hole in the fiber rings and to cut the splines for the contact pieces. It is common practice to finish fifteen or more of these rings at a single pass of the broach. Allowing a floor-to-floor time of 4½ minutes, the time per piece is reduced to eighteen seconds or less.

In blanking the rings out of sheet stock, they are torn. The broach removes the damaged stock, provides an accurate hole for mounting them on an arbor in order to turn the outside diameter, and furnishes a burnished surface for the follower to roll on when the timer is assembled. It is obvious that fiber tubes or rings cannot be chucked like those of metal; but when they are provided with an accurate hole, they may be placed on an arbor and almost any machining work performed on them. This is an ideal condition for the broaching process.

The broaches for fiber rings are so designed that several pieces can be stacked on the broach at one time. In order to permit a large number of thin pieces to be stacked on the broach, the pitch of the broach teeth must be increased, to care for the extra length of the work. Frequently the pitch of the broach teeth is greater than the thickness of one of the pieces in the stack. With the horizontal broaching machine, it is necessary to support the work to prevent it from falling between the teeth of the broach. A pot fixture may be used for this purpose. With the vertical push broaches, this trouble is not so pronounced.

The pitch of the teeth may be made much finer than for metal broaching. A good proportion is obtained by substituting the constant 0.25 for the value 0.35 given in MACHINERY'S HANDBOOK on page 988. In determining the depth of the teeth, it should be borne in mind that the tooth space may be filled, but the chips must not be crowded enough to make it hard to rid the broach of them. A liberal radius or fillet should be given the tooth at its root so that there will be no chance for the chips to jam up at that point. In general, the tooth depth should be from one-half to one-third the pitch, and the radius about one-half the tooth depth. The teeth of round broaches should be liberally supplied with chip-breakers or nicks, properly staggered. The pitch of the nicks should never be greater than ⅜ inch, and 1/32 to 1/16 inch wide. On other types of broaches no chip should be permitted to be over ⅜ inch wide.

All broaches should start from a round hole, and all teeth should be turned as far as possible. It is a mistake to try to broach a square cored or stamped hole. Such a case would require the broach to cut on four sides and the chips would interfere. The broach would be hard to make and hard to sharpen. The cut per tooth may be from 0.007 to 0.012 inch, depending on the strength of the broach. The top clearance of the teeth is generally about 2 degrees, and the rake angle from 10 to 12 degrees.

Some designers taper the pilots of the broach, so that the cut may be started concentric with the outside diameter. This prevents unnecessary turning to provide concentricity, and gives a more uniform wall thickness if there be no turning. With the rapid strides being made in the electrical industry, especially with radio equipment, the writer believes that too much cannot be learned about this material and methods of machining it.

* * *

MACHINE TOOL EXHIBIT IN NEW HAVEN

The New Haven Branch of the American Society of Mechanical Engineers will hold another machine tool exhibition this year at the Mason Laboratory, Sheffield Scientific School, Yale University, September 18 to 21. The exhibition will be held under the joint auspices of the New Haven Branch of the American Society of Mechanical Engineers and the Engineering School of Yale University. In addition to an extensive display of machine, tools and related equipment, some of which will be shown in operation, it is proposed to have evening programs of professional papers, with discussions, as well as afternoon and evening moving pictures of educational industrial films. Information regarding the exhibition may be obtained from Professor Herbert L. Seward, Sheffield Scientific School, Yale University, New Haven, Conn. The 1922 exposition had 135 exhibits and was attended by over 12,000 people.

* * *

MEETING OF AMERICAN INSTITUTE OF MINING ENGINEERS

The 128th meeting of the American Institute of Mining and Metallurgical Engineers was held at Mount Royal Hotel, Montreal, Canada, August 30. Among the papers of special interest in the iron and steel field were the following: "X-ray Examination of Irregular Metal Objects," by Ancel St. John; "X-ray Examination of Steel Castings," by H. H. Lester; "Nitrogen in Steel," by C. Baldwin Sawyer; "Desulphurizing Power of Iron-Blast-Furnace Slags," by Richard S. McCaffery and Joseph F. Oesterle; "Effect of Silicon on Equilibrium Diagram of System Carbon-iron near the Eutectoid Points," by H. A. Schwartz, H. R. Payne, and A. F. Gorton; "Some Commercial Alloys of Iron, Chromium, and Carbon in the Higher Chromium Ranges," by C. E. MacQuigg; "Some Effects of Zirconium in Steel," by Alexander L. Feild; and "Selecting Material for Formed and Drawn Parts," by L. N. Brown.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, August 16

THE conditions in the engineering industries are not so good as they were at the beginning of the year, and few manufacturers are receiving a satisfactory number of orders. There are exceptions, notably in the light motor car industry, structural engineering, and electric machinery. Currency depreciation has again eliminated the Continent from active buying of engineering products. The machine tool industry, however, appears to have passed the worst period, and though, as in other industries, the more optimistic hopes of the beginning of the year have not been realized, there is a slight improvement to be noticed if the industry is considered as a whole. It is reasonable to suppose that the grouping of the railways will bring improvements generally in railway shop practice, and though the first attention has naturally been in the direction of locomotives and rolling stock, railway shop equipment requirements are likely to place demands on several of the makers of heavier machine tools in the very near future.

In the standard lines, there appears to be most business in the Birmingham area, and one well-known maker of turret lathes has not only disposed of a large stock during the past month or two, but has over a hundred new machines in process of manufacture, and these are being sold as fast as they can be completed. The automobile industry and marine engine builders are at present the most prominent among machine tool customers. Another machine tool firm is building a large number of heavy planers, and finds the demand good for wheel lathes as well as boring mills. In this particular shop a large number of men have been taken on, and enough work is in hand to maintain full employment until October.

Makers of punching and shearing machines appear more active, and grinding machines are generally in better demand. More than one machine tool concern owes a certain amount of activity to products out of the field usually covered. Several machine tool firms are undertaking the manufacture of special automatic machinery. Machine tool works are naturally well equipped for this class of work, and the production of machines for piano action parts and the automatic wrapping of loaves of bread may be cited as examples of the class of work that is being undertaken.

In the Glasgow area, one firm has a number of heavy lathes on order for the Continent. Heavy-duty vertical drilling and boring machines have been shipped from this district, and good inquiries are reported for horizontal drilling and boring machines and radial drilling machines.

The demand for small tools remains fairly steady. Some very large orders for files have recently been booked with Sheffield concerns on behalf of the British Admiralty. The Egyptian State Railways and Australia and South Africa are also mentioned as very good markets for Sheffield files.

Overseas Trade in Machine Tools

The returns for the export trade in machine tools during June show a reduction from the previous month. The tonnage fell from 1490 (in May) to 1055, the corresponding values being £153,855 and £110,769. Imports rose from 282 to 406 tons, the value being £53,403 instead of £38,403. The value per ton of exports remained steady at about £105, and that of imports at about £135. The average pre-war figures for value per ton were: Exports £61; imports £97. Lathes and drilling machines figured largely in the exports for June, and lathes and grinding machines represented the greatest values in imports. The value per ton of exported lathes was only £95 whereas imported grinding machines averaged £232 per ton.

General Machine-building Activities

In the majority of the machine-building industries the best that can be said is that the results of the past six months are better than those for the last six months in 1922, but locomotive orders are now few and far between, and many of the big contracts for rolling stock are nearly completed. Electrical shops continue to be active on heavy equipment, especially for the Colonies, where several railway electrification schemes are in progress.

Structural shops are perhaps more regularly employed than any other of the engineering branches, and prices for structural work are now on a cost basis, with a promise of a reasonable profit if the activity continues. Textile machinery makers continue to be fairly busy on account of both home and export orders; and there are signs of increased buying for South America and the Continent.

The marked increase of work in the building trades is reflected in some of the light foundries. Shops specializing in laundry and refrigerating machinery are receiving orders quite regularly. Steam-engine builders and transmission manufacturers in the Yorkshire districts expect little improvement until the cotton, woolen and worsted industries, flour milling and paper making show signs of revival. In these industries even repairs are not put in hand until necessity compels. South Africa and the Colonies generally are taking a fair share of mining and crushing machinery.

The Automobile Industry

In the motor-car industry, business is better than usual at this time of the year. One plant in Coventry has been dispatching 500 engines a week for assembly in a light car that has gained wide popularity during the last twelve months; 1,400 men are employed in three shifts of 8 hours each. New works extensions are expected to make place for another 500 men next year. Special machinery of unique design is being made, and the system of continuous or "line" production is being perfected. The demand for large cars is small, but motorcycle works remain busy. Motorcycle shipments for India are growing. The Albion Motor Co., Ltd., Glasgow, is producing a new vehicle on the caterpillar principle, for countries where the roads are very bad.

Marine Diesel Engines

The Clyde has taken a lead in the matter of the marine Diesel engines, and a large variety of types are now being constructed, which is responsible for a considerable activity which sooner or later must affect machine tool makers. One of the best equipped plants in the country is the Diesel engine shops at Harland & Wolff's extensive new establishment at Govan, where there are some highly interesting tools, and competition is certain sooner or later to call for equipment elsewhere of an equal quality. The engines passing into service at the present time form the first phase of the application of the oil engine to sea conditions.

THE REAL MEASURE OF WAGES

The survey of earnings, employment and working hours made by the National Industrial Conference Board, covering over 600,000 wage earners in twenty-three different industries, shows definitely that average wages today, as compared with the average cost of living, are considerably higher than they were before the war.

The real measure of wages is their purchasing power. The figures collected by the National Industrial Conference Board show that the average hourly earnings of the 600,000 wage earners considered, were, in the spring of 1923, 36 per cent above the purchasing power of the hourly earnings in July, 1914. As the working hours had decreased approximately 9 per cent, the purchasing power of the weekly earnings was 33 per cent above the pre-war level.

This increase in earnings as compared with the cost of living means that the average wage earner is able to consume one-third more than in 1914. As wages are paid out of goods manufactured—that is, out of production—it means also that improved machinery and better working systems have made it possible to produce more than before the war; because only by increased production could the higher wages be paid with a reduction in the number of working hours.

This is something for both workers and labor leaders to consider. Industrial development in ten years has made possible a reduction of nearly 10 per cent in working hours and an increase of over 30 per cent in the purchasing power of wages. That is a very creditable showing for a nine-year period, and labor leaders may well pause to consider whether it is not better to permit this gradual upward trend to continue steadily and peacefully, than to interrupt it with serious disturbances in the form of strikes, or by such rules covering working conditions as limit production and decrease efficiency. The industrial machine has done well during the past decade. Only the obstructionists would throw sand in the gears.

* * *

MORE DATA ON COST REDUCTION

Several other examples of the savings effected in automobile and other plants by using modern machine tools have come to our attention since the editorial in August MACHINERY was published:

An automobile manufacturer formerly employed ten machines and eight men for the machining operations on the cylinders of his engine. The original equipment, which cost $25,000, was recently replaced by two modern semi-automatic machines costing $15,000, and with these two machines instead of ten, and two men instead of eight, the same production was obtained.

In another case an automobile manufacturer employed eight machines of the standard type, working two shifts and requiring sixteen operators to obtain a production of fifty pieces in twenty-two hours. The machine and tool equipment cost $26,000, and it was replaced by a single-purpose machine occupying considerably less floor space than the eight machines formerly used. For this machine only four operators were required, working one shift. The cost of the single-purpose machine was $11,000, and the production sixty-three pieces in nine hours.

In still another case two machines and two men performed a boring operation on twenty-five pieces per hour, while a new semi-automatic turret lathe, with special tooling equipment which required but one operator, produced thirty-seven pieces per hour. The cost of the turret lathe was $2300, and the direct saving $1800 per year.

In small tools, operated in connection with modern machine tool equipment, similar improvements have been made. A tap of special construction used on a high-speed tapping machine has produced 70,000 tapped holes without grinding; and as a tap of this type can generally be reground from ten to twelve times it probably will tap from 700,000 to 800,000 holes before it must be scrapped. This may be a record performance, but in everyday practice one manufacturer, in tapping steel, uses a No. 6-32 tap of this type which regularly taps from 35,000 to 40,000 holes between regrindings, the total number of holes tapped by one tap being about 400,000.

Most machine shops are still operated with some inefficient machine tool equipment, which does not include the marked improvements that have been made during the last five years, and except in the case of a few well standardized machines, the output could be greatly increased by the use of the more modern types. Even in the so-called "standard" types of machine tools—lathes, drilling machines, milling machines, and planers—such great improvements have been made recently in their strength, cutting capacity and ease of operation, that much greater production can be obtained from them, simply because the latest machines can be operated at higher speeds and with heavier feeds—that is, more efficiently.

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JUSTICE TO OUR RAILROADS

The fixed policy of many newspapers to assail the management of our railroads especially entitles the railroads to credit when it is due. Everyone who is practically familiar with them knows that during the last two years wonderful progress has been made in their improvement and rehabilitation, compared not only with war conditions, but with those existing previously. Since January, 1922, some 250,000 freight cars have been ordered, of which about 150,000 have been delivered. During the same period more than 4000 locomotives have been ordered, about one-half of which have been delivered up to date. A shortage of 67,000 freight cars has been turned into a surplus of 75,000 in less than three years. During recent months the railroads have broken all records in the handling of freight, and yet there is a net surplus of freight cars in good repair and immediately available for service. In the week ended July 28, 1,041,044 freight cars were loaded with revenue freight, the largest number for any one week in the history of the country. In October, 1920, nearly as great a freight movement was recorded, but then there was a shortage of over 67,000 freight cars.

The railroads also have been buying a considerable amount of machine tool equipment during the past year, indicating an increasing appreciation of the need for modern machine tools in the railroad shops, and the percentage of locomotives and cars awaiting repairs is unusually small at the present time. Perfection will always be unattainable in railroad operation as in every other industry under the sun; but a closer approach is possible under the management of men who have been working toward it for years along practical lines, than through any of the methods advocated primarily to catch votes.

The Mechanical Education of a Draftsman

By DONALD A. NEVIN, Tool Engineer, Landis Machine Co., Waynesboro, Pa.

THE term draftsman is used in the industries to refer to almost any position from tracer up to that of mechanical engineer. In the following, the writer refers to mechanical draftsmen who have had some training in technical or manual training schools, or who have spent one or more years at the drafting board in making detail or assembly drawings for mechanisms of machinery, in general, and especially for machine tools, special metal-working machinery and equipment, as well as for punches and dies, milling fixtures, drill jigs, milling cutters, and gages. It is the object of this article to point out some of the deficiencies in the training of young men who are ambitious to become first-class draftsmen and designers of machinery and tools. The writer bases his statements upon an experience of many years in charge of a great number of men of this class in both small and large industries, engaged in the manufacture of diversified lines of products.

The most common deficiency among younger draftsmen is the lack of a thorough mechanical education. This is not due so much to the lack of opportunities for instruction as it is to failure on the part of the young men to take advantage of the valuable opportunities that are offered them for acquiring additional education in the evening schools and by reading mechanical books and journals. In nearly all cities, the ambitious young man may attend night school and receive both theoretical and practical instruction at a small cost. Many a draftsman starts as a blueprint boy or tracer, and seems to think that he can learn the trade simply by performing the work that is assigned to him during the working hours of the day. He overlooks the great value of night study and of acquiring additional knowledge through reading. Without study outside of working hours, no man can become a really good draftsman and designer, and certainly he can never become a mechanical engineer. For this he needs not only to acquire a great deal of theoretical knowledge, but must also have the practical experience that can be obtained only through actual work in the factory. Without this experience he will lack initiative and resourcefulness.

The value of practical experience cannot be over-emphasized. A general knowledge of machinery can be obtained from a study of books dealing with the subject, from a review of catalogues, and from watching the machines in operation. But to become a really good designer, the draftsman should actually operate machines and perform practical work. It is seldom that a designer can thoroughly appreciate all the conditions that meet the operator, unless he has done this. The man who has actually handled a machine tool knows how to arrange the knobs and handles conveniently; he appreciates the effort required to shift a belt; and he knows instinctively what will produce chatter in machining. The proper proportion of levers, arms of pulleys and gears, and numerous other machine parts are more easily

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determined by the man who has had an opportunity to be in intimate contact with a variety of machinery; and the draftsmen and designers who have this knowledge will find it much easier to produce creditable work. The ability to invent and design mechanical mechanisms is seldom found in a designer whose training has not included practical experience in the machine shop, although there are many good designers who can produce acceptable designs from sketches that outline and suggest the necessary mechanical movements and the means for obtaining them.

The Need for Knowledge of Mathematics

On the other hand, those designers and draftsmen who have had shop training in many cases lack a knowledge of mathematics. Sometimes a knowledge of some of the processes of arithmetic is lacking, and frequently the draftsman's knowledge of trigonometry and geometry is deficient. Many draftsmen or designers overlook the need for a thorough knowledge of the principles of theoretical mechanics, and therefore are limited in the application of the means for obtaining the desired ends in designing a machine.

A thorough knowledge of such branches of mathematics and theoretical mechanics as are needed by the ordinary draftsman and designer may be obtained from books now available to mechanical students, which have been prepared especially with the needs of the practical man in view. This literature is very complete and within the reach of all. Books on mathematics, machine design, toolmaking, gearing, and practically every other subject that relates to the mechanical field are easily obtained; and engineering handbooks, which are partially reference books and partially text-books, should be a part of the equipment of every draftsman. There is, however, too much indifference on the part of draftsmen and designers in regard to study. They do not take advantage of the opportunities offered to them.

Many draftsmen and designers are not sufficiently familiar with the available technical literature to be able to make practical use of it. The information available in these books has been collected by practical men engaged in every line of work, and should be of the greatest value to other young men in the same line of industrial work. For example, an engineer, who during a period of fifteen or twenty years collected valuable data on automatic screw machine practice, contributed these data from time to time to the mechanical press, and thereby stimulated others to contribute similar information on the same subject. All this material appearing in book form represents a collection of the best practice of many men in many shops.

Waste of Time Due to Lack of Knowledge of Contents of Handbooks

Many needless calculations are made in the shop and drafting-room, not because reference books are not avail-

able, but because the owners of the books are not familiar with the contents of the handbooks in their possession, and do not realize that they could take figures directly out of the handbook instead of spending time in needless calculation. Every draftsman, designer, and toolmaker should look through his handbooks occasionally in order to become thoroughly familiar with the many convenient tables and the vast amount of information on different subjects that they contain. He will find that a good handbook contains conversion factors, convenient multipliers, tables of circumferences, areas, lengths of arcs, tables for spacing holes and circles, tables for figuring tapers, etc., which would prove great time-savers if they were made use of.

Sometimes it may prove of value to the user of a handbook to provide a simplified index for his own individual needs. When he finds that there are certain subjects to which he often refers, he might make notes in pencil on the fly-leaf in the front of the book of those particular subjects. Care should be taken to exclude all indexing of subjects that are not referred to very often, because the regular index is more convenient for general reference; but this auxiliary index for quick reference may aid the owner to find without delay those particular tables in the book to which he most frequently refers. If a man refers very frequently to certain tables in the handbook, he will, of course, become so familiar with their location in the book that he will need no index at all.

There is very little truth in the assertion often heard: "I can figure this out in less time than I can find it in a handbook." That is very seldom the case. Furthermore, the figures given in handbooks have been carefully checked. Their accuracy can be more safely depended upon than the accuracy of the worker's own calculations.

Needless calculations are also frequently made to determine angles and lines by trigonometry, when great accuracy is not required. In many cases, a lay-out to an enlarged scale would give angles and lengths of lines as accurately as would be needed for the purpose, and the answer could be measured by a protractor or scale in a fraction of the time required for the trigonometrical calculations.

> A thorough knowledge of such branches of mathematics and theoretical mechanics as are needed by the ordinary draftsman and designer may be obtained from books now available to mechanical students, which have been prepared especially with the needs of the practical man in view. This literature is very complete and within the reach of all. Books on mathematics, machine design, toolmaking, gearing, and practically every other subject relating to the mechanical field are easily obtained, and engineering handbooks, which are partially reference books and partially text-books, should be included in the equipment of every draftsman.

Home Study for the Machinist Apprentice

As the best draftsmen and designers in the general machinery and machine tool field are generally drawn from the apprentices who have completed part or all of a shop apprenticeship, a few words on the home study necessary for a shop apprentice may be of value. Frequently the apprentice is started in the tool-crib, where he has an unusual opportunity to learn, provided he has an inquiring mind. Here he can become familiar with the uses of every tool and appliance that he hands out, and then at night he can study elementary mechanical books, catalogues, and advertisements in mechanical journals, and thus obtain a great amount of information relating to general tool equipment. The average mechanic, and especially the apprentice, often overlooks the fact that the advertisements in mechanical journals contain a vast amount of information on shop practice of great value. The advertisements change from month to month, and by studying these regularly, the reader becomes familiar, not only with the varied equipment that is available, but also with the makers of equipment for different classes of work.

The apprentice should also purchase a number of elementary books on machine shop practice, shop arithmetic, gearing, and elementary machine design. If he expects to be able to work independently, he must also become familiar with patternmaking and foundry practice—branches of work with which he may not come in direct practical contact in the shop. The apprentice who studies at home has an opportunity of studying mechanical problems that have come up during the day and of acquiring all the knowledge on these subjects that is available in mechanical books. He may also reverse the process, and use what opportunities he may have to observe in the shop the operation of machines and the application of methods about which he has studied in his books the night before. The really ambitious young man can acquire a complete encyclopedia on machine shop work if he so wishes, in which he will find information on all the types of machinery and tools ordinarily used in machine shops and on all methods generally employed.

After he has acquired an elementary knowledge of mechanical subjects, the ambitious young man will go further in his studies. He will begin to read books on methods of production, efficiency, factory management and systems, because he will look forward to the day when he will not be a mere cog in a machine, but one of the men who lead instead of follow. On the other hand, if he has inventive ability and desires to become a machine designer, he will obtain some of the books available on machine design, tooling equipment, and advanced practical mathematics. The subjects chosen should be those that are in close contact with the work on which the student is engaged or that cover the line of engineering that he intends to make his life work. Publishers of technical books can usually advise as to what particular books would be most suitable for a young man to study, provided he will state his experience and the line of work for which he is endeavoring to fit himself.

The Toolmaker Apprentice

The apprentice who intends to become a toolmaker and tool designer should endeavor to become familiar with every phase of work required in toolmaking practice. For example, if the young man serves his apprenticeship with a firm engaged in building machine tools, he may have little opportunity to become familiar with punches and dies during his apprentice period. A knowledge of punch and die work, however, is very important to any man who wishes to be a toolmaker, and although he may not specialize in it, he should acquire all the knowledge on this subject that he can obtain by reading the books available on punch and die design. A good toolmaker also needs a fair knowledge of mathematics. He certainly should understand the elements of trigonometry, and have a thorough grounding in all the methods of arithmetic. A knowledge of these subjects is easily obtained from the simplified treatises available today. A toolmaker equipped with a knowledge of mathematics is more valuable than one who cannot perform his own calculations; he can command higher pay and is in line for promotion.

While it is not necessary for a tool and die maker to be proficient in drafting, he should know how to make sketches, and should be able to lay out a simple design on paper, if called upon to do so. A good toolmaker should have studied a book on mechanical drawing, and should know enough about that subject so that he can make use of all the methods ordinarily employed in drafting practice. It is the ability to do a little more than the job actually requires that makes it possible to secure advancement.

A Course of Study for Draftsmen and Designers

Perhaps the best way for the draftsman to acquire shop practice is to pass through a regular apprenticeship, but it is also possible for him to obtain sufficient practical experience by working as a helper in a shop while studying drafting and the other necessary subjects. Certainly he should not try to enter the drafting-room until he has had at least a year's experience in the shop.

Many student draftsmen make the mistake of undertaking the more difficult studies before they have laid a solid foundation. No attempt should be made to study algebra, geometry, trigonometry, and machine design until all the elements of arithmetic have been thoroughly mastered. After that, is it well to study the purpose of various machine tools and the principles involved in different production methods, and to obtain a general knowledge of mechanical movements. When this has been done, a more advanced course in mathematics and machine design will prove not only more helpful, but also more interesting.

If the young man will study at home while he is working in the shop, he will undoubtedly have a much better chance of obtaining a position in the engineering field that will support him immediately, than he would have after having attended an engineering school for four or five years without having any practical experience. A correspondence school course in designing and mechanical engineering should not be taken unless the student is simultaneously employed in a mechanical line of work, because it is only by carrying on the theoretical and the practical work side by side that real success can be expected; but it is quite possible to learn to draw from studying the books and courses provided on mechanical drawing, which are usually very thorough. In studying drawing, it is of great value to obtain blueprints of detail drawings and assemblies. It is also of great value to study the illustrations in mechanical journals, as the instruction thus obtained supplements that given in the books on drawing.

In addition to studying mechanical drawing, the young man fitting himself to become a draftsman and designer should study some book that will teach him the elements of algebra and trigonometry, and elementary treatise on theoretical mechanics, the strength of materials and machine design, patternmaking, and molding. He must also learn something about the materials that are used in engineering design, and he will find that there are good books available on iron and steel and on the heat-treatment of steel. Then, in these days of specialization, he may devote himself to some particular line of engineering, and will have to choose books dealing with that particular field.

Tool Designers and Production Engineers

Should he desire to become a tool designer or tool equipment engineer, the subjects that he should study, in addition to those already mentioned, are toolmaking practice, punches and dies, automatic screw machine cams and tools, drilling jigs, milling fixtures, cutters, grinding, gear-cutting, broaching, welding, boring, shaping, and planing.

If he expects to fit himself for a production engineer, he needs to include books on time study, wage systems, bonus systems, shop systems, and the routing of work. A good production engineer should be especially familiar with the design of cams for automatic screw machines, dial and roller feeds on punch presses, combination and multiple dies, the design of milling cutters and other cutting tools, and the use of special machinery.

In these days, when developments follow each other so rapidly, even the successful engineer must remain a student in order to keep pace with the rapid advancement that is being made in the mechanical industries. Fortunately, the mechanical journals provide him with a review of the advances made, so that he can follow the progress by spending a few minutes daily with a journal in his field.

PRODUCTION POSSIBILITIES OF THE POWER PRESS

By A. EYLES

Many articles formerly spun from sheet metal are now produced faster, better, and more economically in the power press, and numerous parts that were forged or cast have also been replaced by pressed parts that are fully as satisfactory and much cheaper. Some idea of the output of modern sheet-metal working machinery may be gained from the following figures taken from actual practice:

One type of automatic press has a capacity for producing brass caps for fuse plugs from No. 30 gage strip brass at the rate of over 9000 pieces per hour. Another press is capable of producing seamless drinking cups at the rate of over 2100 per hour. This machine is run at about 9 strokes per minute and averages 532 operations per hour, drawing four cups at a time. Another press is capable of cutting washers from strips of hard-rolled steel 1/16 inch thick at the rate of 540 washers per minute.

With an automatic double seaming machine it is possible to simultaneously double-seam the top and bottom to the body of square and irregular shaped sheet-metal boxes up to 8 inches wide and 12 inches high at the rate of 10,000 ends per day. An automatic inclined press will produce over 50,000 circular sheet-metal stampings per day, and it is possible for one workman to attend to two or three machines at the same time. Power press work is usually a matter of long runs, thousands or hundreds of thousands of pieces being required, and it is because of this fact that it is profitable to make the dies. Yet in some shops where there is but a small amount of manufacturing done on a large scale, it is often necessary to do work of this kind in small quantities.

Punches and dies for cutting tin plate require grinding approximately once for every 100,000 cuts, while tools used with sheet steel must be resharpened once for every 10,000 or 15,000 cuts. The reason for this great difference is that there is no scale on tin plate, as it is removed prior to the tinning process. With light brass or copper articles, it is not always necessary to harden the punch, and this considerably reduces the cost. No hard-and-fast rules can be laid down relative to hardening punches; sometimes it is not convenient to harden them on account of the shape of the article to be produced.

* * *

CATALOGUES SENT ABROAD

A number of foreign countries impose duties on catalogues and other sales literature. It frequently happens that when a catalogue is sent to some country where a duty is imposed, the addressee finds it necessary to go through all the ordinary custom house red tape that is required in connection with a large shipment, and in addition he is expected to pay the duty assessed and possibly a fee to a custom house broker who attends to the matter. The Department of Commerce states that it has happened that catalogues have cost the foreign addressee $5 or more. This obviously does not put the prospective customer in a suitable frame of mind for buying, even though it is true that his own government is responsible for the folly of assessing duty on trade information.

In order to assist the American business man in handling his foreign advertising matter and catalogues, the Foreign Tariff Division of the Bureau of Foreign and Domestic Commerce, has in course of preparation a series of bulletins describing in detail the restrictions imposed in various countries of the world. The list of this series is Trade Information Bulletin No. 122, entitled "Shipment of Samples and Advertising Matter to the British Empire." Copies of this bulletin may be obtained by addressing the Foreign Tariffs Division, Bureau of Foreign and Domestic Commerce, Washington, D. C.
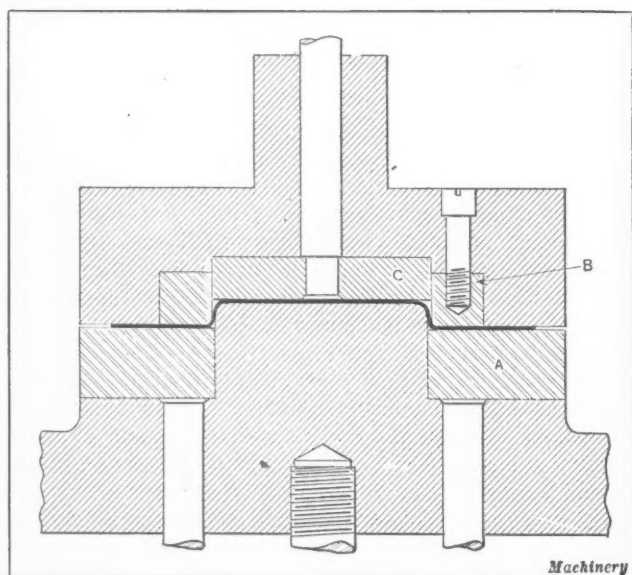
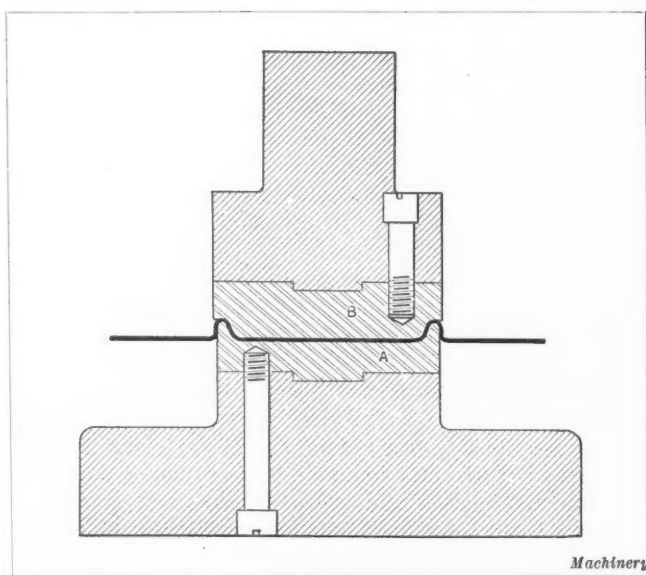Fig. 1. Preliminary Drawing Operation on the Bottom of a Metal Coffee-grinder

Fig. 2. Operation in which the Raised Portion of the Bottom of the Coffee-grinder is inverted

Dies for Producing a Square Part

By J. BINGHAM, President, The Bingham Stamping & Tool Co., Toledo, Ohio

A NUMBER of interesting dies are used in manufacturing the bottom of a square coffee-grinder and in assembling this part to the body of the grinder. The square shape, of course, makes the operations far more difficult than if the part were round. No. 20 gage material is used for this part, which is about 4 inches square and ¾ inch deep when completed. The blanking die has no unusual features in its design, and for that reason is not illustrated.

The blank is taken to a press equipped with draw-pins, a rubber buffer, and the plain drawing die illustrated in Fig. 1, on which it is drawn to the shape of the heavy full line, both the flange and raised portion being square and having rounded corners. The die-block is made of cast iron, and has a hardened and ground tool-steel part A by means of which the blank is pressed against the punch face while it is drawn, part A being actuated by the draw-pins and the rubber buffer. The punch is also an iron casting, and has hardened and ground inserted facings B. After an operation is completed, the work is forced from the punch by the knock-out rod and pad C at its lower end. The work, of

course, is forced from the die, in the event that it adheres to the latter, through the functioning of the rubber buffer and the draw-pins.

In the next operation the piece is beaded in the die shown in Fig. 2. Block A is of an outside diameter that permits the work to be slipped over it. Then, when the punch descends on the downward stroke of the ram, the major portion of the raised section of the part is inverted by face B, as indicated by the heavy line. If the flange on the work were not so long, it would be possible to accomplish this and the preceding operation at the same time. The die-block and punch are made of cast iron, while faces A and B are made of tool steel, and are hardened and ground.

Forming and Trimming Operations

The next step in the production of the bottom of the coffee-grinder is performed on a press equipped with the die shown in Fig. 3. This die is also used in connection with a rubber buffer and draw-pins. The die-block is made of cast iron, and provided with hardened and ground tool steel parts A, B, and C. The punch is also made of cast iron, and has
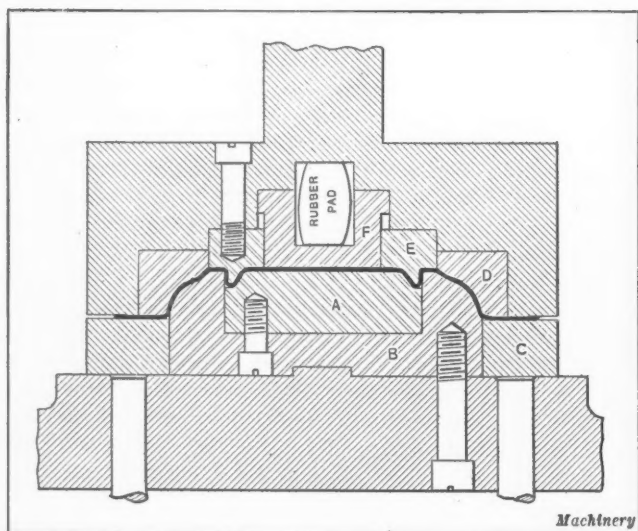

Fig. 3. Forming Punch and Die of Unusual Construction necessitated by the Square Shape of the Work
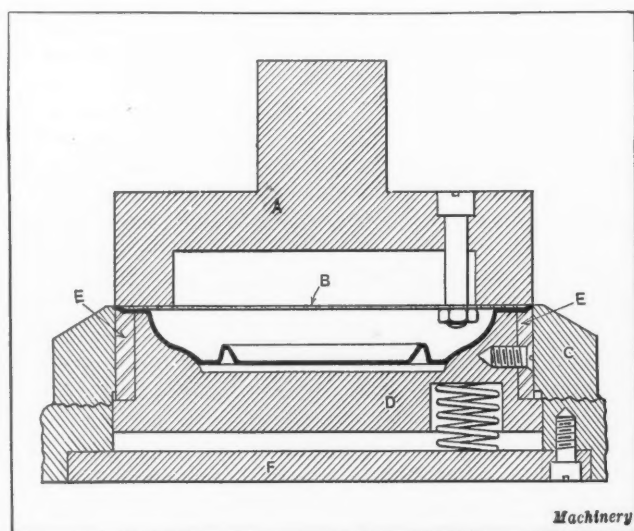

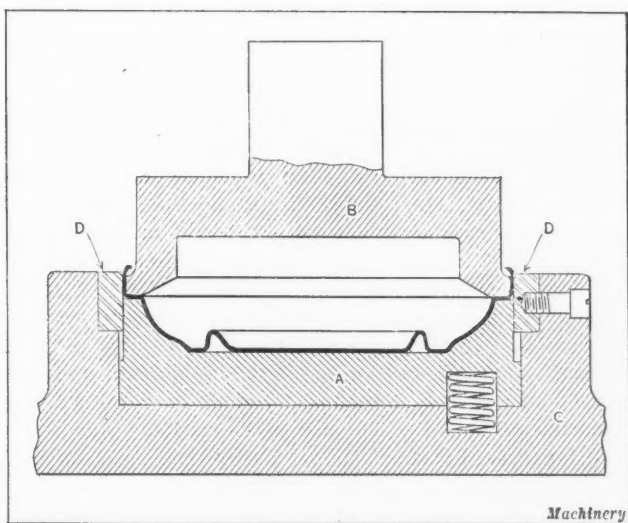Fig. 4. Die for trimming the Flange of the Work and slightly curling up the Edges

Fig. 5. Bending back the Flange preparatory to curling the Edge

Fig. 6. Operation in which the Edge on Each of the Four Sides is curled

tool-steel parts *D*, *E* and *F*. Prior to the descent of the punch, part *C* is in a raised position, its upper surface being in alignment with the top surface of parts *A* and *B*. Then as the punch descends, the blank is held securely between the face of the punch and the die part *C*, and is drawn to the shape illustrated. Knock-out *F* advances slightly ahead of the other punch members, owing to the action of the rubber pad, and thus serves to hold the blank on die part *A*.

The work is forced from the punch at the completion of the operation through the action of the knock-out *F*, and it is lifted from the die members as the draw-pins again raise part *C* to its normal position. If one die part were used, instead of parts *A* and *B*, it would be necessary to mill a recess in the face to form the inverted bead. The double construction makes the parts far easier to machine, and thus results in a considerable saving in time and money. In addition, member *A* can be replaced as it becomes worn without requiring replacement of part *B*.

The die equipment illustrated in Fig. 4 is employed for trimming the flange and at the same time slightly turning up the edges all around to facilitate a succeeding operation. Punch *A* is made of tool steel, and there is a sheet *B* of tool steel fastened to its face by means of machine screws. These screws pass through accurate holes in the sheet, and serve to hold it in the correct position relative to the die. The work is trimmed as punch *A* passes the top edge of die member *C*, sheet *B* functioning at the end of the stroke to turn up the edges, as already mentioned. The work is
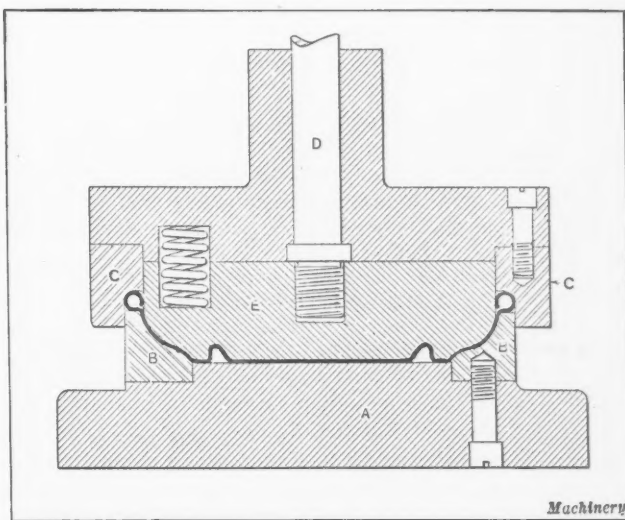
properly located for the operation by die part *D*, which is machined to suit the contour of the work.

Part *D* is raised somewhat at the time the punch comes in contact with it through the action of coil springs placed in counterbored holes in its lower side. It is forced downward as the punch descends, and when the punch rises on the upward stroke of the ram, it is again lifted by the coil springs. By means of this construction the work is forced from the die. Part *D* is made of cast iron, and has a tool-steel plate *E* set on each of its four sides. The upper section of die member *C* is made of tool steel, and the lower part of wrought iron, the two parts being welded together. Plate *F* is inserted in the bottom of die member *C* to hold the part *D* and its springs in the die.

Bending back the Flange and Curling it

The next operation, which consists in bending back the flange, is performed with the die illustrated in Fig. 5. It will be seen that this die is designed along the same lines as the one just described. The work is placed in die member *A*, which, previous to the descent of the punch, is held in a raised position by the coil springs shown, its top edge being in a line with the top of die-block *C* and the inserted pieces *D*. Part *A* is made of cast iron, while punch *B* is made of tool steel and hollowed out to reduce its weight.

The final operation on the piece prior to assembling consists of curling or wiring the lower edge. This is accomplished by means of the punch and die shown in Fig. 6. The work is correctly located in the die by the four tool-steel pieces *B*, which are attached to the die-block *A*. When the punch descends, knock-out *E*, which is advanced ahead of the other punch members by the action of several coil springs between it and the punch proper, is the first to come in contact with the work. At this point knock-out *E* remains stationary while the other punch parts continue to descend, thus exerting an increasing pressure on the work as the coil springs are compressed, and holding the work in a fixed position.

The edge of the work is curled as parts *C* on the punch slide over parts *B* on the die. It will be obvious that there
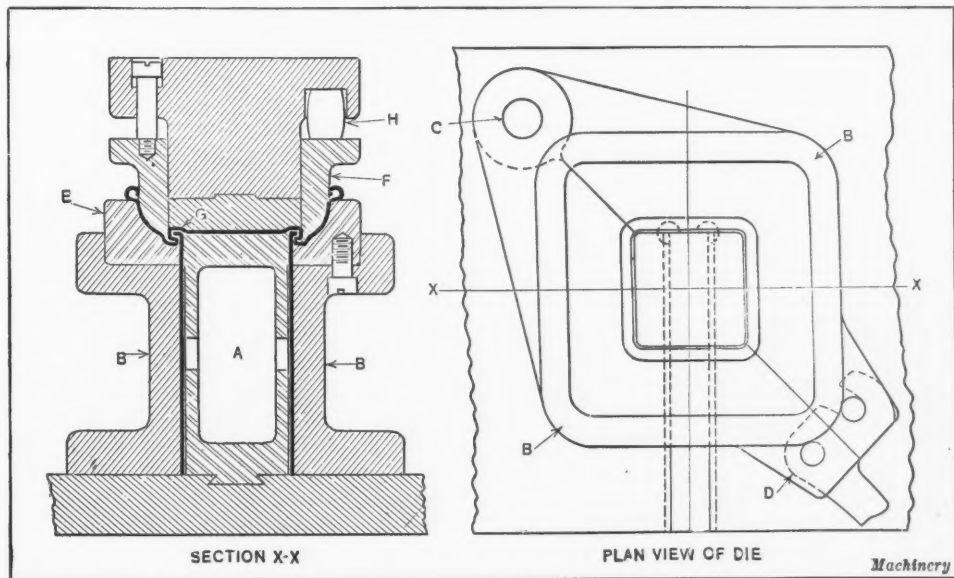

SECTION X-X   PLAN VIEW OF DIE

Fig. 7. Hinged Die employed in assembling the Bottom to the Grinder Body

must be an accurate fit between parts B and C. This curling operation is considerably facilitated by the fact that the edge of the work is slightly curved in the previous operation. On the return stroke of the punch, knock-out E remains stationary as parts C slide from parts B, and thus holds the work in the die, from which it can be readily removed as the punch reaches the end of its upward stroke. Should the operation of the knock-out fail to remove the work from the punch members, it is forced out when rod D is operated at the end of the stroke.

Assembly of the Coffee-grinder

The assembly of the bottom to the body of the grinder is performed by means of the punch and die shown in Fig. 7; this illustration shows a section through the punch and die members, and a plan view of the die. It will be apparent that the body of the grinder is first placed on the upright die member A, after which jaws B, which swivel on pin C, are brought together and locked by lever D. The body is approximately 4 inches square. The bottom of the grinder is then seated on die parts E, which are attached to the top of the jaws.

Two different punches are used with this die, the second of which is shown. The first punch is solid and has an angular face that begins bending the edge of the bottom at G, so that it can be completely bent around the flange of the grinder body by means of the second punch, shown in the illustration. Member F is provided with rubber pads H to advance it ahead of the punch proper and the face attached to the punch.

* * *

BROACHING VULCANIZED FIBER

By GEORGE E. HODGES

Some of the various methods employed in machining vulcanized fiber were described in June MACHINERY on page 781. Although not dealt with in that article, broaching has been found to be a very satisfactory and economical method of machining certain parts made from vulcanized fiber. The writer believes that a few pointers regarding the broaching process will be of value to those engaged in the manufacture of fiber products.

One of the most interesting applications of the broaching process is in the production of timing rings for automotive igniting systems. Practically all the large manufacturers who make timing rings are now using broaches to accurately size the hole in the fiber rings and to cut the splines for the contact pieces. It is common practice to finish fifteen or more of these rings at a single pass of the broach. Allowing a floor-to-floor time of 4½ minutes, the time per piece is reduced to eighteen seconds or less.

In blanking the rings out of sheet stock, they are torn. The broach removes the damaged stock, provides an accurate hole for mounting them on an arbor in order to turn the outside diameter, and furnishes a burnished surface for the follower to roll on when the timer is assembled. It is obvious that fiber tubes or rings cannot be chucked like those of metal; but when they are provided with an accurate hole, they may be placed on an arbor and almost any machining work performed on them. This is an ideal condition for the broaching process.

The broaches for fiber rings are so designed that several pieces can be stacked on the broach at one time. In order to permit a large number of thin pieces to be stacked on the broach, the pitch of the broach teeth must be increased, to care for the extra length of the work. Frequently the pitch of the broach teeth is greater than the thickness of one of the pieces in the stack. With the horizontal broaching machine, it is necessary to support the work to prevent it from falling between the teeth of the broach. A pot fixture may be used for this purpose. With the vertical push broaches, this trouble is not so pronounced.

The pitch of the teeth may be made much finer than for metal broaching. A good proportion is obtained by substituting the constant 0.25 for the value 0.35 given in MACHINERY's HANDBOOK on page 988. In determining the depth of the teeth, it should be borne in mind that the tooth space may be filled, but the chips must not be crowded enough to make it hard to rid the broach of them. A liberal radius or fillet should be given the tooth at its root so that there will be no chance for the chips to jam up at that point. In general, the tooth depth should be from one-half to one-third the pitch, and the radius about one-half the tooth depth. The teeth of round broaches should be liberally supplied with chip-breakers or nicks, properly staggered. The pitch of the nicks should never be greater than ⅜ inch, and 1/32 to 1/16 inch wide. On other types of broaches no chip should be permitted to be over ⅜ inch wide.

All broaches should start from a round hole, and all teeth should be turned as far as possible. It is a mistake to try to broach a square cored or stamped hole. Such a case would require the broach to cut on four sides and the chips would interfere. The broach would be hard to make and hard to sharpen. The cut per tooth may be from 0.007 to 0.012 inch, depending on the strength of the broach. The top clearance of the teeth is generally about 2 degrees, and the rake angle from 10 to 12 degrees.

Some designers taper the pilots of the broach, so that the cut may be started concentric with the outside diameter. This prevents unnecessary turning to provide concentricity, and gives a more uniform wall thickness if there be no turning. With the rapid strides being made in the electrical industry, especially with radio equipment, the writer believes that too much cannot be learned about this material and methods of machining it.

* * *

MACHINE TOOL EXHIBIT IN NEW HAVEN

The New Haven Branch of the American Society of Mechanical Engineers will hold another machine tool exhibition this year at the Mason Laboratory, Sheffield Scientific School, Yale University, September 18 to 21. The exhibition will be held under the joint auspices of the New Haven Branch of the American Society of Mechanical Engineers and the Engineering School of Yale University. In addition to an extensive display of machine tools and related equipment, some of which will be shown in operation, it is proposed to have evening programs of professional papers, with discussions, as well as afternoon and evening moving pictures of educational industrial films. Information regarding the exhibition may be obtained from Professor Herbert L. Seward, Sheffield Scientific School, Yale University, New Haven, Conn. The 1922 exposition had 135 exhibits and was attended by over 12,000 people.

* * *

MEETING OF AMERICAN INSTITUTE OF MINING ENGINEERS

The 128th meeting of the American Institute of Mining and Metallurgical Engineers was held at Mount Royal Hotel, Montreal, Canada, August 30. Among the papers of special interest in the iron and steel field were the following: "X-ray Examination of Irregular Metal Objects," by Ancel St. John; "X-ray Examination of Steel Castings," by H. H. Lester; "Nitrogen in Steel," by C. Baldwin Sawyer; "Desulphurizing Power of Iron-Blast-Furnace Slags," by Richard S. McCaffery and Joseph F. Oesterle; "Effect of Silicon on Equilibrium Diagram of System Carbon-iron near the Eutectoid Points," by H. A. Schwartz, H. R. Payne, and A. F. Gorton; "Some Commercial Alloys of Iron, Chromium, and Carbon in the Higher Chromium Ranges," by C. E. MacQuigg; "Some Effects of Zirconium in Steel," by Alexander L. Feild; and "Selecting Material for Formed and Drawn Parts," by L. N. Brown.

Cutting Instrument Gears

Application of the Hobbing Process and Production of Small Pinions in Rod Form—Second of Two Articles

By FRANKLIN D. JONES
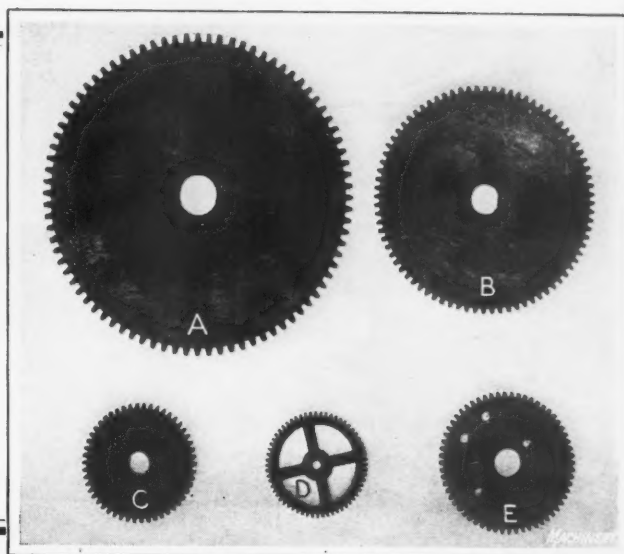
THE gear-hobbing machine illustrated in Fig. 14, which is made by the Meisselbach-Catucci Mfg. Co., Newark, N. J., is especially designed for cutting the gears and pinions in meters, gages, clock movements, etc. While this machine is intended primarily for cutting spur gears, worm-gears can also be cut on it by using a hand feed. The illustration shows the machine hobbing spur gears. A stack of gear blanks A is placed on the arbor, this being the usual method whenever practicable. The hob B is rotated through shaft C, having universal joints to permit a feeding movement for the hob. Change-gears at the rear of the machine drive shaft D, which in turn revolves, through suitable gearing, the work-spindle, and through additional gears and shafts, the feed-screw for the hob slide. In setting up the machine, the required speed ratio between the hob and work is obtained by the change-gears at the rear.

When the hob has finished its cut across the stack of gear blanks, a stop is reached which releases a half-nut engaging the feed-screw, thus stopping the feeding movement. At the same time the driving belt is shifted to the idler pulley, so that the hob stops revolving and the flow of cutting oil or compound also discontinues, which facilitates removing the work and inserting another lot of uncut blanks. After the half-nut has been disengaged, the hob slide can be returned to the starting position rapidly, simply by sliding it along the ways by hand instead of turning the feed-screw. As the actual cutting time is very short on most of the work handled on a machine of this kind, it is essential to reduce the idle time between cuts to a minimum. That is why provision is made for the rapid hand adjustment of the hob slide.

While the output of a gear-cutting machine, as well as of any other machine tool, varies widely for different classes of work, the following specific examples illustrate in a general way what has been done on the type of machine shown in Fig. 14. Brass spur gears having 90 teeth of 80 diametral pitch were hobbed at the rate of 240 per hour. This rate is not given as representing unusual production, but the output for certain instrument gears of good quality. These gears were 0.020 inch thick,

and in cutting them, 100 were placed on an arbor at the same time.

As the gears have spokes and a hole in the center which is small in proportion to the gear diameter, a special arbor was used. Instead of using a very small arbor which simply passes through the center holes, this special arbor has segments that fit between the spokes, in addition to a small central spindle for the holes. This type, which holds the work more securely and increases production, will be illustrated later in connection with another gear-cutting operation.

Another example of work is the cutting of steel spur gears having 18 teeth of 18 diametral pitch. These gears have a face width of ⅜ inch, a ½-inch hole, and a long shoulder, so that only two can be cut at a time; consequently, the production in this case is five minutes per gear, or twelve gears per hour.

Some instrument gears cut at the plant of D. S. Plumb, by the hobbing process, are shown in the heading illustration. These are all brass gears, and a Meisselbach-Catucci hobbing machine was used for cutting the teeth. Gear A has 84 teeth of 24 pitch, and is made from No. 11 gage stock. Twenty blanks are placed on an arbor and cut simultaneously. The production rate is 100 per hour. Gear B has 80 teeth of 26 pitch, and the rate of production on this job is 120 gears per hour, twenty being placed on one arbor. Gear C has 50 teeth of 40 pitch, the production rate being 200 per hour. This gear is made of No. 13 gage stock. Gear E has 60 teeth of 40 pitch, and the blanks are made of No. 13 gage stock. Twelve are placed on one arbor, and the production rate is about 144 per hour.

An interesting example of rapid gear-cutting on the Meisselbach-Catucci machine is shown in Fig. 15. This machine is cutting brass spur gears for water meters. The gears are like the sample shown at D in the heading illustration; they have 60 teeth of 52 diametral pitch, and are made of No. 18 gage stock. Thirty-five are placed on an arbor at one time, and the production is about 500 per hour. This gear-cutting operation illustrates the use of the segment type of arbor,
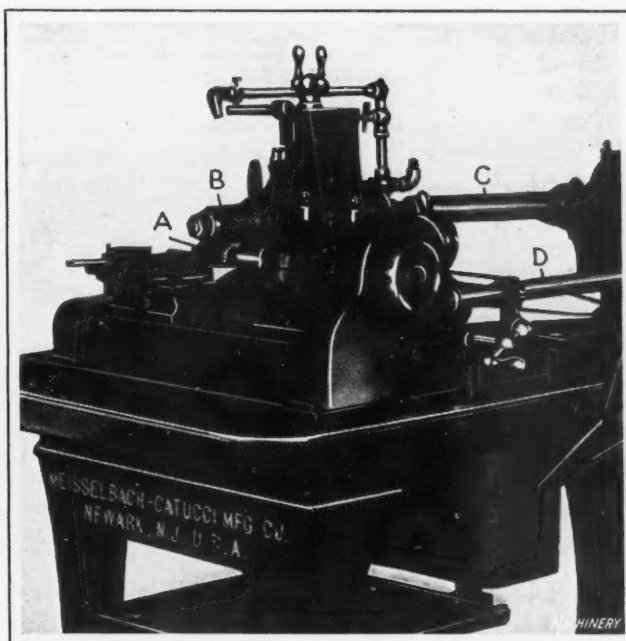

Fig. 14. Hobbing Machine used for cutting Instrument Gears
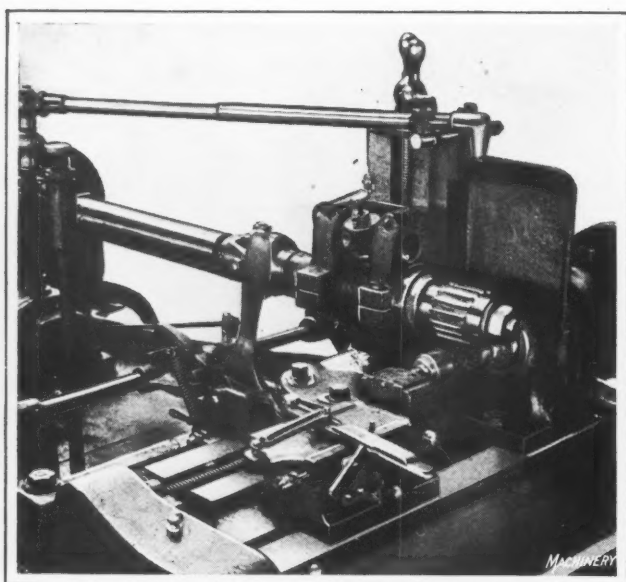
Fig. 15. Hobbing a Stack of Thirty-five Water-meter Gears

which is made to pass between the spokes of the wheel as well as through the central hole. One of these arbors loaded with gear blanks is shown in Fig. 16. An endwise view of another similar arbor is shown at the right-hand side of this illustration, the clamping nut having been removed, to show how the arbor segments fit between the spokes of the gear blanks. The blanks are centered by a pin A; this pin, in turn, is accurately located by the hole in plug B, which is pushed over pin A before screwing on clamping nut C. This sleeve nut screws over the ends of the segment-shaped arbor sections and bears against the outer gear blank rim, thus holding the blanks rigidly. The gear blanks are

Fig. 16. Segment Arbor used for Operation illustrated in Fig. 15

not turned, but are placed in the gear-hobber just as they come from the blanking die. This die cuts the blanks slightly over-size, and the hob takes a light cut over the tops of the teeth, thus finishing all of the tooth surfaces.

While all the examples of instrument gear work previously referred to represent cut gears, it will be understood that a great many small gears for use in clock mechanisms and various other classes of instruments are produced by means of sub-press dies. Cut gears are preferable for accurate work, although very accurate gears are produced in well built sub-press dies, provided the thickness of the stock is not excessive.

Making Small Pinions in Rod Form

Many small steel and brass pinions are produced by first making the pinion in rod form, and then cutting the rod into whatever lengths are required for the pinions. In other words, the teeth are formed along the rod, which may have a length of three or four feet. The companies making pinion rod usually sell it in rod form, and the manufacturer using the rod cuts it into short pinion lengths. Either a hand screw machine or an automatic is generally used for this purpose, the machine being employed to cut whatever shoulders, holes, or bearing surfaces are required for the pinion. The teeth on pin-

ion rods may be formed either by a cutting process or by drawing plain rod through suitable dies.

Machine for Cutting Pinion Rod

The type of machine used by the Meisselbach-Catucci Mfg. Co. for cutting pinion rod is shown in Fig. 17. This is a machine of the hobbing type. The uncut rod is inserted at the rear end A of the work-spindle, and it feeds automatically through the spindle past the hob B, which generates the teeth. A section of cut pinion rod is shown projecting beyond the hob.

At C is located a mechanism which feeds the pinion rod through the spindle, while the spindle and hob revolve at the proper ratio, as controlled by change-gears at the opposite side of the machine. The feeding mechanism has a stationary worm about which a small worm-wheel revolves, transmitting, through additional worm-gearing, a feeding motion to serrated rolls between which the pinion rod passes. The hob may be adjusted axially in order to center a tooth relative to the pinion rod when the number of teeth in the latter is small. This hob takes a very light topping cut; that is, it removes a slight amount of stock from the tops of the teeth in order to finish the outside concentric. This is important because when the pinion rod is afterward placed in the screw machine, it is gripped by the outside. Pinion rod having helical or spiral teeth may be cut on this machine. Provision is made for setting the hob to the angle required, by swiveling the head that carries the hob-spindle.

Drawn Pinion Rod

Cold-drawn pinion rod is produced by methods that, in a general way, are practically the same as the methods employed for making cold-drawn rods or other sections. Care has to be exercised in determining the various reductions and annealings, in order to obtain the correct shape of tooth and size of rod, as well as the most suitable temper in the finished rod, for obtaining good cutting qualities. A. B. and J. Rathbone, of Palmer, Mass., manufacture drawn pinion rod in brass up to 1⅛ inches in diameter, and in steel up to 1 inch in diameter. This drawn rod can be supplied in lengths varying from 6 to 12 feet, according to
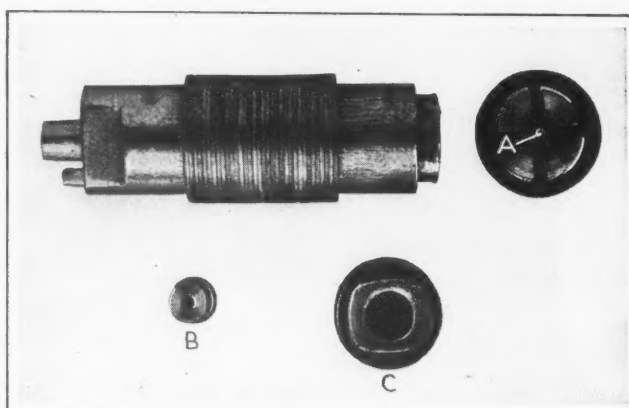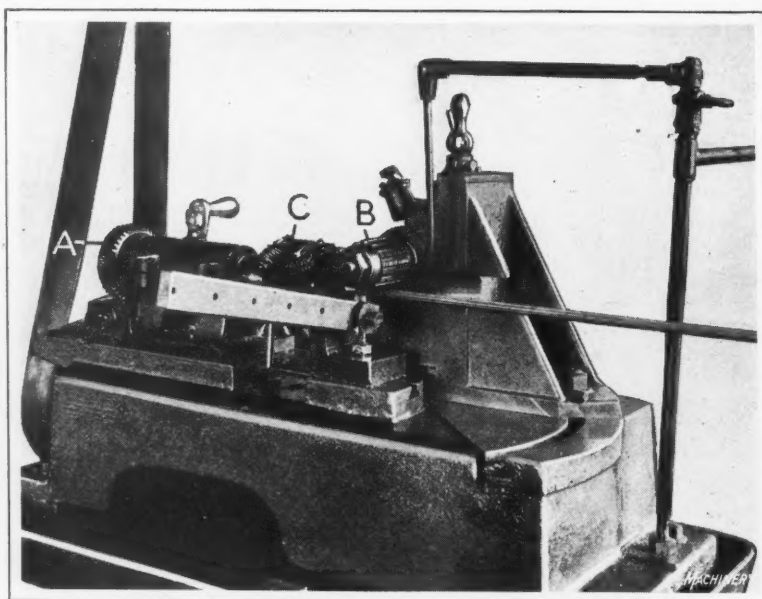

Fig. 17. Special Machine for cutting Pinion Rod by Hobbing Process

diameter. The Rathbone process of drawing is said to compress the metal and give a smooth hard finish to the wearing surfaces. This drawn pinion rod is used in the manufacture of clocks, watches, speedometers, gas meters, water meters, and electric meters, moving picture machines, typewriters, adding machines, slotting machines, mechanical toys, and many other devices.

* * *

CUTTING CAST IRON AND COPPER WITH THE OXY-ACETYLENE TORCH

Cutting cast iron by the use of the oxy-acetylene torch is being done with remarkable success in many cases. Special tips are used owing to the great heat and the large amount of oxygen required. The ease of cutting seems to depend largely on the physical character of the cast iron, very soft cast iron being more difficult to cut than harder varieties. The cost is much higher than for cutting the
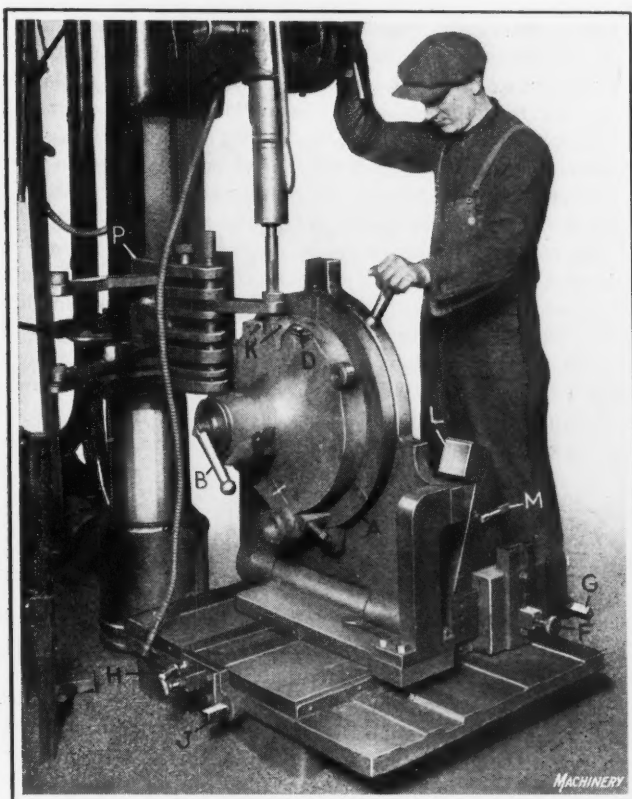

Fig. 1. Universal Angle-plate Drilling Fixture in Position for machining Holes in a Vertical Plane

same thickness of steel, because of the larger pre-heating flame necessary and the greater oxygen consumption. In spite of this, however, this method is economical in many cases. The slag from a cast iron cut contains considerable melted cast iron, while in the case of steel, the slag is practically free from particles of the metal. This indicates that cast iron cutting is partly a melting operation. Increased speed and decreased cost can often be obtained by feeding a steel rod, about ¼ inch in diameter, into the top of the cut, just beneath the torch tip. This furnishes a large amount of slag which flows over the face of the cut and increases the temperature of the cast iron, thereby accelerating the melting.

The cutting of copper may be done by the use of the steel rod referred to. This is very largely a melting operation, the slag from the steel rod running down over the face of the copper cut and bringing it to the melting temperature, when the high-pressure oxygen jet blows out the melted metal. The slag from this operation consists largely of copper globules, much iron oxide, together with some copper oxide.

UNIVERSAL ANGLE-PLATE DRILLING FIXTURE

The use and general application of a universal drilling fixture for handling casings for all sizes of turbines made by the Coppus Engineering Corporation, Worcester, Mass., is described in the following. Blueprinted sketches of the casings are supplied for use in connection with the fixture, which are mounted on cardboard and hung in a cabinet on the wall, as shown in Fig. 3, so that they can be swung out and referred to when desired. On each blueprint are instructions for indexing the fixture when drilling the holes. For a particular size of turbine case, certain index-holes are used; these are numbered on the fixture itself, and their correct selection is made by referring to the instructions on these sketches. The blueprint cabinet is located in close proximity to the machine on which the drilling fixture is used. By this arrangement a new operator can perform the drilling operations as well as a more experienced man.
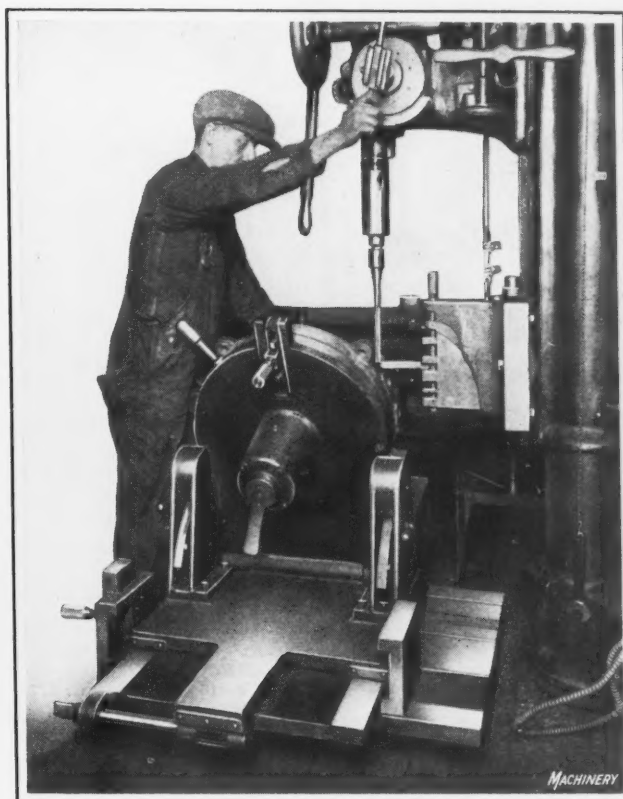

Fig. 2. Fixture set in an Inclined Position for reaming the Nozzle Pin Holes in Turbine Casing

Figs. 1 and 2 show the fixture in two positions. The regular table of a Reed-Prentice upright drilling machine is taken off, and the fixture is mounted on the finished ways of the baseplate of the machine and located by means of dowel-pins in the exact position. As may be seen, the upright part of the fixture rests on the finished ways of one plate, and this plate, in turn, rests on similar finished ways of another plate, so that movements at right angles to each other can be obtained. In addition to this, the upright part of the fixture can be swung at an angle, from the center on which it is hinged.

The casings have a central hole, which is machined on a vertical boring mill; while this operation is taking place, the hub is faced on both ends, the surface against which the casting is clamped in the drilling fixture is faced, and the inside is bored. The casings are then located by finished pads on index-plate A, Fig. 1, of the fixture, and clamped to it by means of handle B, which tightens a washer against the outer end of the hub. The plate and work are indexed together and clamped in the desired position by means of a handle on the opposite side of the plate (see Fig. 2). The

casting is prevented from turning by a set-screw in a lug that projects from the plate, this set-screw bearing against a boss on the periphery of the casting, as shown in Fig. 1. The index-plate is mounted on two ball bearings, so that when the clamp is released and the index-pin withdrawn it will turn freely to the desired position.

Machining Holes in a Vertical Plane

After the casting has been clamped in place, it is located in position for machining the steam inlet hole, as shown in Fig. 1. The cast surface of the boss serves to locate the work, in connection with an arbor having an enlarged head, which is slipped into the sleeve of the machine spindle. This arbor head is about the same diameter as the boss, and thus the two can be readily aligned. After the steam inlet hole has been machined, the index-plate is turned through 20 degrees, first front and then back, for machining the two valve-top holes, one of which is shown at D. These holes are in the same vertical plane as the steam inlet hole, so that it is only necessary to withdraw the index-pin at the top of the plate (see Fig. 2), and swing the plate to the correct angle, using graduation marks on the index-plate as a guide.
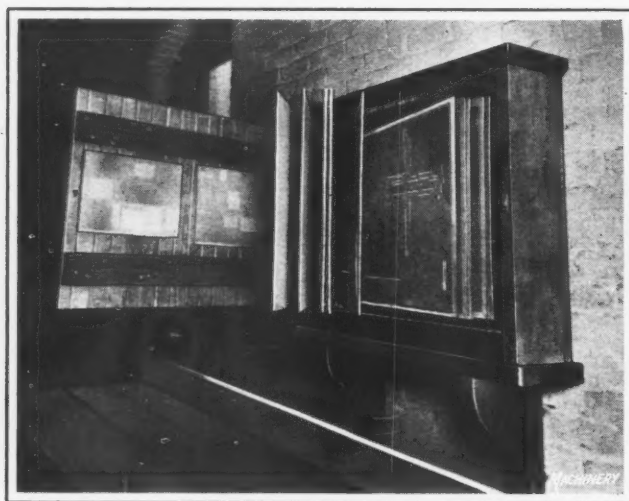

Fig. 3. Blueprint Cabinet containing Sketches with Instructions for indexing the Fixture

After the valve-top holes have been machined, the oil-drain and oil-inlet holes in the hub are drilled. These are located diametrically opposite each other, and in adjusting the fixture, index-pin F, Fig. 1, is withdrawn, and a crank is used on screw G to move the top plate toward the operator. It will be noticed that there are a number of index-holes in which the pin F can enter. The selection of the proper hole is determined by reference to the blueprint for the size of casing being machined. One hole is drilled in the hub; then it is indexed 180 degrees for the other, locating with the index-pin at the top of the plate.

The oil-level hole is next drilled in the hub. This hole is between the other two, but is not a radial hole, being one inch off the center of the hub. In order to move the fixture in one inch to obtain this setting, the clamp H is released, the index-pin F withdrawn, and the crank-handle used to operate screw J. The plates are graduated in inches, so that the setting can quickly be obtained.

Use of Fixture when set at an Angle

The next holes to be drilled are the angular so-called "nozzle holes" K which intersect the three large holes first drilled. The amount and direction in which the fixture must be moved to give the correct settings vary with different diameter castings, the proper setting being determined from the blueprint. The top plate is moved forward the required amount, and the upright part is moved away from the operator (Fig. 1), and securely clamped in place. The upright is then inclined 20 degrees until it rests against

brackets L, where it is clamped by handles M. The curved arms, working in these brackets, (see Fig. 2) have strips attached to them, which act as stops when the fixture is located in its vertical position.

After the fixture has been set at the 20-degree angle, the three holes are drilled and taper-reamed, the plate being indexed in the manner previously described for drilling the valve-top holes. The nozzle holes break through on the inside of the turbine casing at an angle, so that in order to maintain the correct width of the elliptical holes where the tools break out, it is necessary to provide stops for the reamers. This is done by employing lugs on the index-plate, which extend within the casting and prevent the end of the reamer from being fed too deep. The reaming operation is illustrated in Fig. 2.

One other special provision on this machine is the bracket P, Fig. 1, which carries the drill bushing arms. This bracket may be moved up or down on the vertical column, and the bushing arm for any particular sized tool swung into position and located by a long taper pin which passes through the entire length of the bracket. It is a simple matter to remove this pin and swing the bushing arm out of the way when the fixture is being adjusted or the tools are being changed; then when the operation is to be performed, the proper arm can be easily swung into position. The bracket is quite heavy and overhangs considerably, so that it has been found advisable to counterweight it.

All the index-pin bushings are hardened and ground, and all the pins are spring-actuated, so that when indexing or making a new setting of the plates the index-pin will snap into place. This fixture has been in use a long time in this plant. Before the fixture was built, it required six hours to perform these operations on one piece, whereas the present production is fifteen castings in a nine-hour day. Translated into dollars and cents, this means that if the cost of machining previous to the use of the fixture was $6 per casting, it is now only 60 cents.

* * *

THE BETHLEHEM STEEL CO.'S EMPLOYES' REPRESENTATION PLAN

The first report on the results of the Bethlehem Steel Co.'s plan of employe representation, which has been in effect since 1917, has been made public by Eugene G. Grace, president of the company. The Bethlehem plan is briefly summarized as follows: Elected employe representatives with negotiating powers through committees of their own choosing, pass upon every matter relating to employment relationship that has not been settled to the satisfaction of all parties through a direct understanding with the ordinary plant authorities. The representatives also discuss and make constructive suggestions upon matters for the good of the business that are in no sense grievances, but that the employes may be interested in. Their suggestions in many instances have proved decidedly helpful.

During the period since the plan went into effect 2365 cases have been handled by the employe's representatives, of which 71 per cent were settled in favor of the employes, 14 per cent against the employes, 8.5 per cent were withdrawn by the employes concerned after the facts in the case had been brought out, and 4 per cent were compromised.

As to the character of the questions raised, 612 out of the 2365 cases were concerned with working conditions, and 570 cases dealt with wages, piece work, and bonus schedules. Two hundred and ninety-eight cases dealt with safety and accidents, and an equal number with engineering methods and economy. Approximately 25 per cent, of the total, were chiefly concerned with health, sanitation, transportation, pensions, and sick relief; and 119 cases related to housing conditions, education, recreation, and other subjects less closely related to the actual work in the plant. President Grace states that the plan has been successful.

High-speed Spindles for Screw Machines

Special High-speed Equipment for Automatic Screw Machines, Operating on Brass, with Examples Showing Production of Parts in Three Seconds or Less

By LUTHER D. BURLINGAME
Industrial Superintendent
Brown & Sharpe Manufacturing Co.
Providence, R. I.
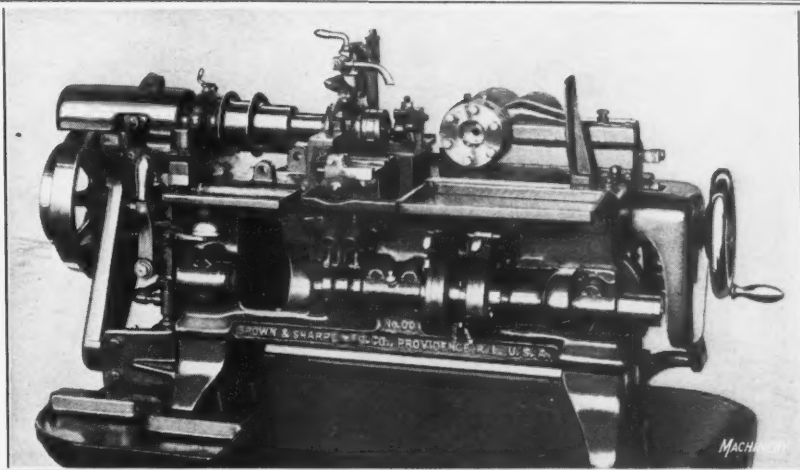
EXAMPLES of brass, aluminum, and other soft metals produced on regular Brown & Sharpe automatic screw machines at high rates of production were considered in the article "Screw Machine Products Made in Less than Three Seconds," which appeared in March MACHINERY. In that article it was suggested that additional means might be devised for speeding up the machines so as to obtain even greater production rates than are possible with the regular machines. For some time the Brown & Sharpe Mfg. Co. has been adapting to its regular machines a high-speed spindle especially designed for increased production with brass and other free-cutting metals, whereby the investment in machines is decreased and less floor space occupied per piece produced. The regular machines equipped with the high-speed spindles are equally well suited to the use of attachments for slotting and light milling, index-drilling, burring, etc. These attachments make it possible to perform auxiliary operations of a great variety at the same time as main operations, thus not only reducing the time otherwise required for rehandling, but also avoiding the use of other machines.

Means of Speeding up the Machines

The means for obtaining this high-speed production provide for: (1) Speeding up the spindle, which is made possible by supplying roller bearings and ball thrust bearings as well as a special provision for oiling; and (2) speeding up the driving shaft which is effected by substituting special clutches, gears, etc., to reduce the time of the idle movements. The machine can also be changed to move the turret through two spaces at one indexing by means of double rolls on the indexing disk, thus in some cases avoiding the use of duplicate sets of tools. Any one or all of these methods can be used to advantage, as will be explained in connection with the examples given in this article.

Speeding up the Spindle

In the case of the No. 00 automatic screw machine equipped with a reversing spindle, the maximum speed is increased 50 per cent or from 2400 to 3600 revolutions per minute. The design of this machine is such as to take the shock of reversing at the higher speed. In the case of the No. 00 turret forming and cutting-off machines having non-reversing spindles, the speed is more than doubled, as the spindle runs at a maximum speed of 5000 revolutions per minute. A No. 00 automatic turret forming machine equipped with a high-speed spindle is shown in the heading illustration. At A in Fig. 1 is illustrated the high-speed non-reversing spindle and parts for this machine and for the cutting-off machine; at B, the high-speed reversing spindle for the No. 00 automatic screw machine. These are substituted for the regular spindles and parts.

The roller bearings previously mentioned are in the rear boxes. For machines where the spindle speed is doubled, the front bearing is provided with a special oiling system, which insures a constant and uniform lubrication. A special countershaft pulley is also employed. In the case of the non-reversing spindle, the feed-slide bracket shown with the spindle at A, Fig. 1, is supplied to take the shock of feeding the stock. On the No. 00 automatic turret forming machine the spindle pulley is located close to the rear bearing, so that bearing will take the pull of the belt. With this construction the close limits within which work is handled on the regular machines can be maintained even when running at the much higher speeds.

Saving Time During Idle Movements and Indexing the Turret Two Stations

By using special clutches, gears, etc., as previously mentioned, to speed up the driving shaft, the speed of that shaft is doubled, so that only one-half the time previously taken is necessary for the movements controlled by that shaft. This saving is especially noticeable when the idle time consumed in indexing the turret and feeding the stock is greater than the actual cutting time. This change limits the capacity of the machine by reducing the longitudinal movement of the turret slide from $1\frac{1}{4}$ to $\frac{5}{8}$ inch on the No. 00 machines, which is necessary to lessen the strain and
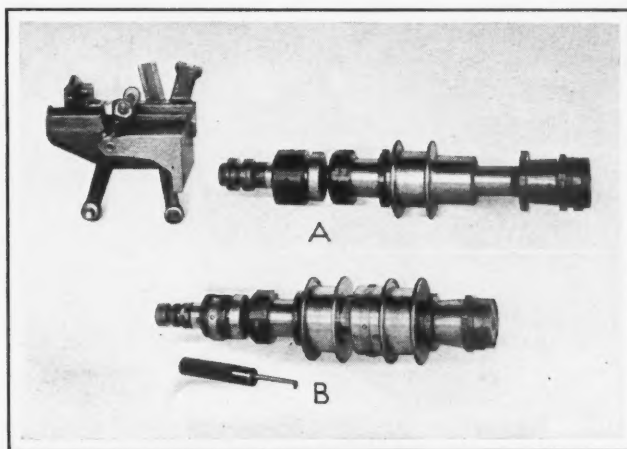
Fig. 1. (A) High-speed Non-reversing Spindle and Feed-slide Bracket; (B) High-speed Reversing Spindle
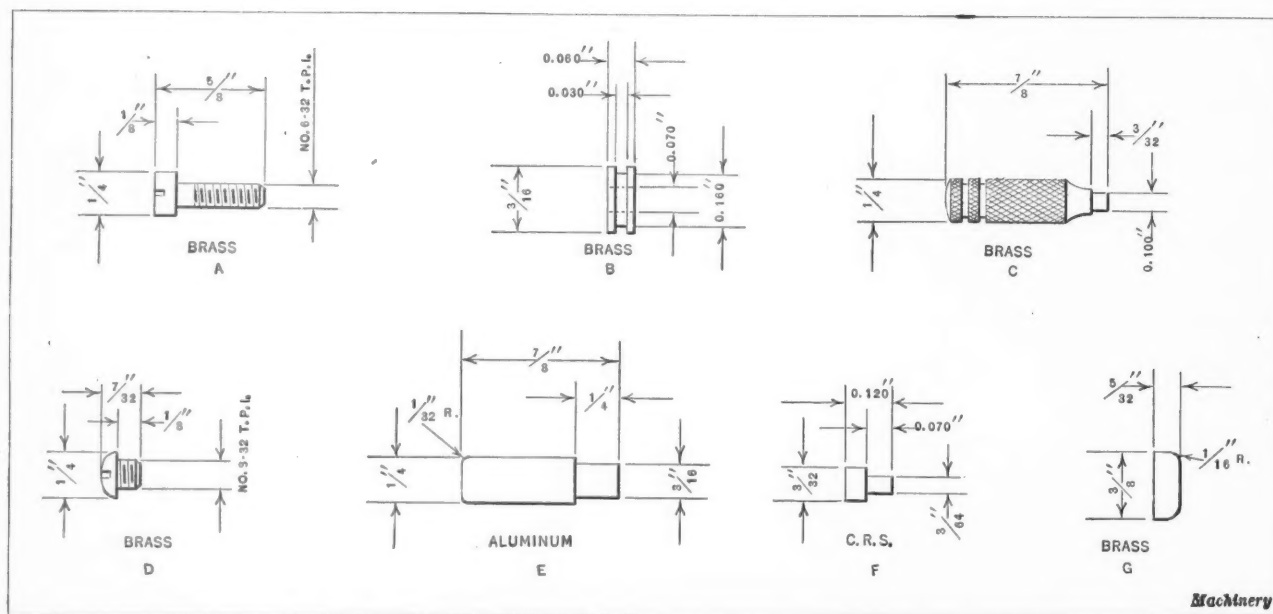
Fig. 2. Examples of Brass, Aluminum and Cold-rolled Steel Parts produced in Three Seconds or Less

shock on the turret slide when indexing at the higher speed. The feeding capacity in this case is also reduced from 2 to 1 inch.

When only three turret positions are required, a device can be used to advantage to move the turret through two spaces at each indexing, as mentioned before, thus making a complete turn of the turret in three indexings. Such a device is shown in Fig. 3, from which it will be seen that instead of only one roll engaging a slot in the turret, two rolls engage two slots, so that one turn of the disk indexes the turret two holes. This device makes unnecessary the use of two sets of tools in the turret, and the indexing is done in the same length of time as before.

Examples of Work

Examples of work of such a type that a material saving of time can be made by using these speeded-up machines are shown in Fig. 2. The part shown at A requires the full automatic machine for its manufacture, because of the threaded part. Following is a comparison of the amount of saving possible by using all of the means of speeding up, or only one or two of them.

The estimate sheet in Fig. 4 shows that this piece can be produced, including the slotting, in three seconds, or at a net production rate of approximately 1080 screws per hour, by using all the means here suggested for increasing production. If, on the other hand, the high-speed spindle were used without using the fast driving shaft, four seconds would be required per piece, giving a net production of about 810 pieces per hour. The production of the regular machine on this part would be five seconds and the net production only about 640 screws per hour. With the method indicated in Fig. 4, advantage is taken of indexing the turret two spaces at each indexing, which, while not reducing

Fig. 3. Arrangement of Mechanism for Indexing the Turret Two Holes Each Time

the time required, avoids the necessity of providing two sets of tools for the turret.

Samples B, C, and D, Fig. 2, are produced on the turret forming machine with the spindle running at 5000 revolutions per minute. Part B is an example of drilled work produced on this type of machine in two seconds or at a net production rate of 1620 pieces per hour. Tools in the turret center and drill the part, and there is a stock stop. The estimate sheet for this piece is shown in Fig. 5. If the spindle only were speeded up, and not the back shaft, the time required would be three seconds per piece, giving a net production rate of 1080 pieces per hour, while if the part were made on the regular machine the time would be four seconds per piece, giving a production of 810 pieces per hour. In producing the knurled part C, one position of the turret is required for a stop and another for a turret knurl-holder, the forming and cutting-off operations being performed by tools on the cross-slides. On both these pieces double indexing can be applied to eliminate an extra set of tools in the turret. The screw shown at D is an example of threaded work produced on a machine where the spindle does not reverse. This screw is made in two seconds, including the slotting. In this case the thread is rolled by a tool in the front cross-slide, and the forming and cutting-off operations are performed by tools in the back cross-slide. The turret is indexed to allow the slotting arm to clear the stop and pick up the piece.

Speeding up the Automatic Cutting-off Machine

Examples E, F and G, Fig. 2, do not require reversing the spindle nor the use of turret tools, and can therefore be made on the cutting-off machine. All the work can be performed by cross-slide tools, only a stop being required in the turret to feed the stock to. The spindle is driven at 5000 revolutions per minute.
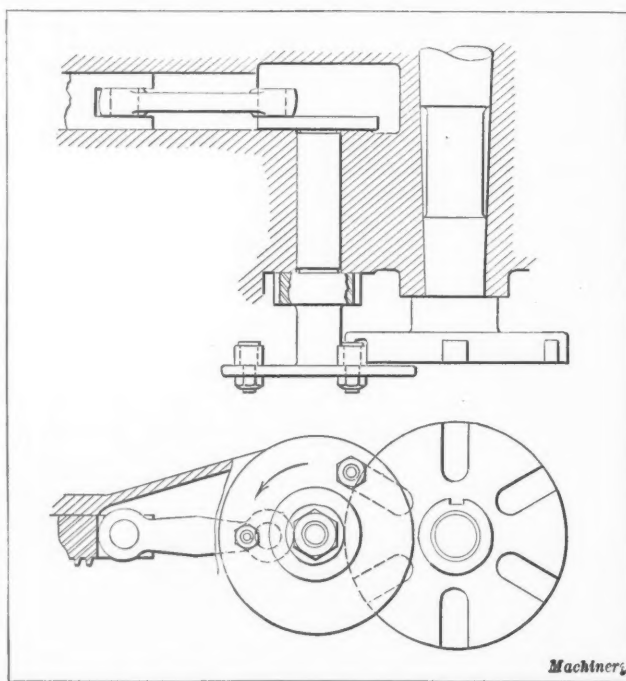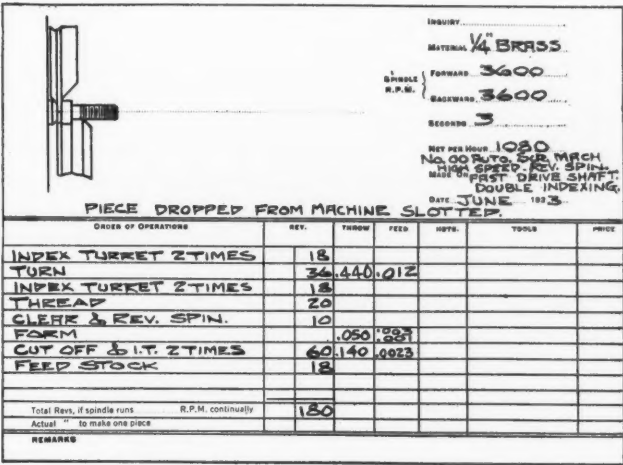
Fig. 4. Estimate Sheet for Screw A, Fig. 2, when the Machine has all the Means for Increased Production

Fig. 5. Estimate Sheet for Drilled Piece B, Fig. 2, indicating Possibility of doubling Production

Part *E* is made in 1¼ seconds or at a net production of 2560 pieces per hour. Were this same piece made on the regular machine it would take 2½ seconds each. Part *F* is produced from 3/32-inch mild steel at the same rate as part *E*, or 2560 pieces per hour. This example illustrates the possibilities of producing steel pieces with the machine speeded up, although it would not be practicable to run larger diameters of steel at this speed. The work in producing part *G* consists of rounding the corners and cutting off. What is termed the "double method" of producing screw machine parts is used in this case, similar tools being provided on both the front and rear cross-slides so that two pieces are machined simultaneously. This method is illustrated on the estimate sheet in Fig. 6. On jobs where this method is employed, the two parts are produced in about the same time that it would ordinarily take to produce one. The front tool slightly overlaps the second, so that the front piece will be cut off first. This over-lapping of the cutting-off operations can be carried to the point where the minimum amount of stock remains on the second piece for driving while cutting off the first. These parts are produced in one second each or at a net production of 3240 pieces per hour.

Conclusion

This article has been confined to parts made in three seconds or less, but it will be seen that the same proportional production increase can be obtained on parts of larger size or on which there are more operations to be performed, and which consequently require a longer time to complete. The machines thus adapted to high-speed work are intended for use in working brass, nickel-silver, aluminum, and such free-cutting metals. In all the estimates, the net production per hour has been considered as 90 per cent of the gross production, and commmercial limits of plus or minus 0.001 inch on all decimal figures were assumed.

* * *

Statistics published by the British Ministry of Transports show that on May 31 of this year, there were in Great Britain 346,000 privately owned automobiles, 79,000 taxicabs, 166,000 commercial trucks, and 387,000 motorcycles. On these a tax of over $50,000,000 was collected, the average whole-year license for privately owned automobiles being about $80; for trucks $100; and for taxicabs $125.
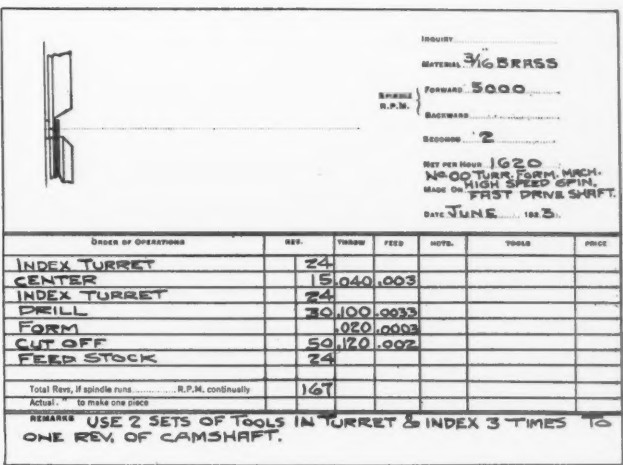

Fig. 6. Estimate Sheet for Piece G, Fig. 2, which is produced at the Rate of 1 Second Each

BALANCE OF FOREIGN TRADE

For several months the value of the imports into the United States has exceeded the value of the exports. This reversal of the trade balance is not due to a shrinkage in exports, but to increases in the imports, and a study of the records shows that the imports of raw and semi-raw materials for use by the industries in this country are responsible for much of the increase. The manufacturers apparently have found it necessary to import larger quantities of raw materials to care for the recent increased volume of manufactured goods. It must also be remembered that, like England, the United States is now a creditor nation, and as such we must expect that our imports will exceed our exports, because, in the long run, the only way in which our foreign debtors will be able to pay the interest and principal of their debts will be by materials and goods imported into this country.

* * *

REGIONAL MEETING OF THE A. S. M. E.

A regional meeting of the American Society of Mechanical Engineers will be held Tuesday and Wednesday, October 23-24, at Chattanooga, Tenn. This meeting will be conducted by the local section at Chattanooga, with the cooperation of the neighboring sections in the South. At the technical sessions, one of the subjects to be taken up will be welding. Other papers to be read at the meeting will deal with hydro-electric power plants and the use of Tennessee coal in pulverized form for industrial plants. The final session of the meeting will be devoted to the subject of management, two papers being planned.

* * *

FIRST STEEL MADE IN THE UNITED STATES

The first steel produced in the United States, according to the Geological Survey, Department of the Interior, was probably made in Connecticut in 1728, by Samuel Higley and Joseph Dewey. Crucible steel was first successfully produced in the United States in 1832 at the works of William and John H. Garrard, at Cincinnati, Ohio. Bessemer steel was first made in this country in September, 1864, by William F. Durfee, at an experimental plant at Wyandotte, Mich., and open-hearth steel by the New Jersey Steel & Iron Co. at Trenton, N. J., in the same year as the first Bessemer steel.
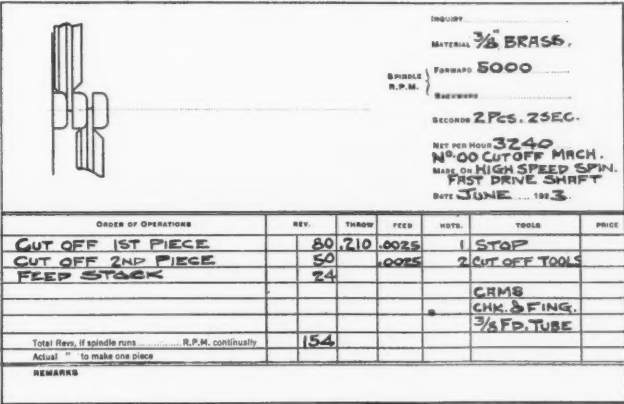
MACHINE USED IN MAKING ELECTRIC INCANDESCENT LAMPS

The most common type of electric lamp globe has a tip at the large end, formed when the tube by which the lamp is evacuated is melted off. The tip is useless and undesirable; it adds nothing to the efficiency of the lamp and is more or less of a detriment, because if hit accidentally, it may be broken off and the lamp ruined. These objections to the design of an electric lamp globe having a tip at the end have been overcome by evacuating the lamp from the opposite end, and the way in which this is done is rather interesting. The automatic machine employed is illustrated in Fig. 1; it assembles the glass flare A, Fig. 2, with a glass tube B through which the air is evacuated, a glass cane C and the two lead wires D to the lower ends of which the filament is clamped. The lead wires are placed between the tube and the flare.

This machine which is manufactured by Charles Eisler, Newark, N. J., is known as a "stem" machine. It is driven by a ¼-horsepower motor located directly beneath the table. The machine has an indexing turret with six stations, the indexing being accomplished by a Geneva gear, the driver for which is located beneath the table at the front of the machine.

The parts that are assembled in this machine are carried in special heads, shown in Fig. 1, which revolve on their own axes at the four stations of the machine where work occurs. These heads, upon reaching an operative station, are driven by a rubber-covered disk which contacts with a steel toothed pinion at the lower end of the driving shaft of the head. The pinions are covered by guards cast integral with the turret, and they have fine saw teeth which press into the rubber-covered disks, so that the driving action is similar to an ordinary gear and pinion. However, this construction obviates all shock due to the engagement of a gear and pinion, as well as backlash due to wear, and is a quiet jarless means of power transmission. The main driving shaft, located directly beneath the table, is connected by spur gears to a parallel auxiliary shaft from which these disks are revolved by means of a chain and sprocket wheels.

In operation, the operator stands at the front of the machine and inserts a flare between the two brass jaws A, Fig. 1, of a head, with its lower end resting on a brass seat. The brass seat is drilled with blind holes, as indicated in Fig. 2. The operator then inserts two lead wires D into the outer blind holes, the depth of which is such that when the part is completed the wires will extend from the flare,

the necessary amount to permit clamping the tungsten filament to them.

The flare is held in an upright position under light tension by a coil spring connecting the two jaws, and after the wires have been put in place, the top clamp B, Fig. 1, is swung back to permit a cane and tube to be inserted. The tube is passed between the two lead wires and held erect by the top clamp, which is brought into position by pressing the brass finger-lever C. This lever and the lower end of the two jaws A are insulated against heat by fiber pads.

Brass is used in electric lamp machinery, in preference to iron or steel, whenever the part is one that makes contact with molten glass because glass does not adhere to brass and the latter is not likely to corrode. The brass castings are often not polished except by filing. Another advantage in using brass castings instead of iron ones is that they can be bent considerably, as compared with the slight changes in shape that peening will produce in an iron casting. Castings or levers, such as jaws A, Fig. 1, can be bent to engage the glass part evenly, or in any way desired.

At the second station the head is revolved while a single jet of gas is directed against opposite sides of the flare, to preheat it uniformly at the bottom. When the workhead reaches the next station, the intensity of the heat is doubled by using two jets of flame on each side, which soon brings the lower end of the flare into a molten condition preparatory to flattening to the shape shown by the central diagram in Fig. 2. This is accomplished by two levers D, Fig. 1, operated by a link motion from plunger E, which extends down through the center of the head. The plunger is raised by a cam-lever which brings two jaws on the upper ends of levers D together with sufficient pressure to flatten the lower end of the flare and the glass tube within it.

At the fourth station, the end of the flare is again made red-hot, but a jet of cool air is directed down against the top to prevent it heating it all over. A stream of air at a pressure of approximately ¼ pound per square inch is then admitted into the evacuating tube from the pipe F, which results in blowing a hole through the flattened end of the flare. The hole will be blown through the thinnest portion at the lower end of the tube, just where it is flattened into a solid piece, about as indicated at E, Fig. 2. The other pipe extending down near pipe F, Fig. 1, is the cool air pipe for the top of the flare.

This completes the assembling of the units, which at the fifth station are simply revolved and heated with a single flame from opposite sides, to permit the glass to be reduced in temperature gradually, so that it will not crack from sud-
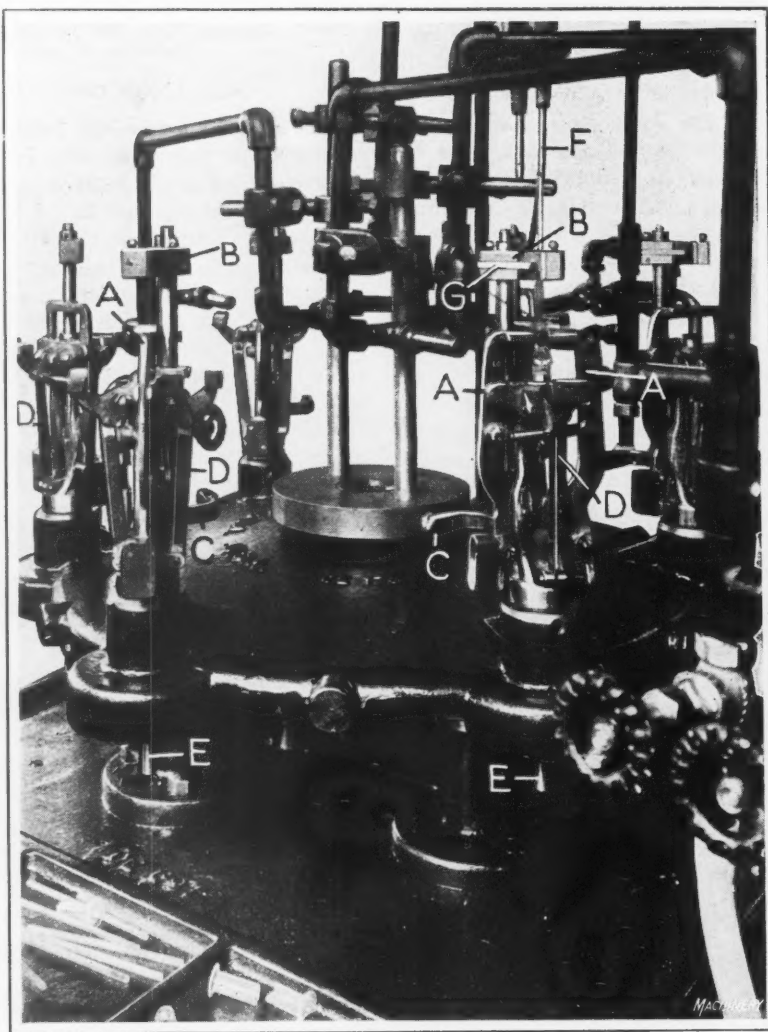

Fig. 1. Machine for assembling Internal Glass Parts and Lead Wires of the Lamp

den exposure to the atmospheric temperature. At the sixth and last station, which is the one at the operator's left, the work is removed and at the same time the station in advance of it is loaded, this arrangement being timed so that one operator will be busy constantly loading and unloading.

The top clamp B has a sliding jaw G which, prior to unloading, is withdrawn less than 1/16 inch by pressing the finger-lever C lightly. The shaft that carries this top clamp is tubular, and contains an inner shaft, to which the finger-lever is fastened; the inner shaft has a pin in its upper end that produces the slight movement of the jaw when the shaft is turned by the lever. Then, as the finger-lever is depressed further, this pin engages a slot in the tubular shaft and causes the entire clamp to swing out of the way, so that loading and unloading will not be hampered. When lever C is completely depressed, the jaws A are opened and the work removed.

The tubular shaft has two conical depressions in its upper bearing, in one of which a spring-actuated steel ball becomes seated to lock the clamp when it is swung back; in its forward position, it is locked by the ball seating in the other
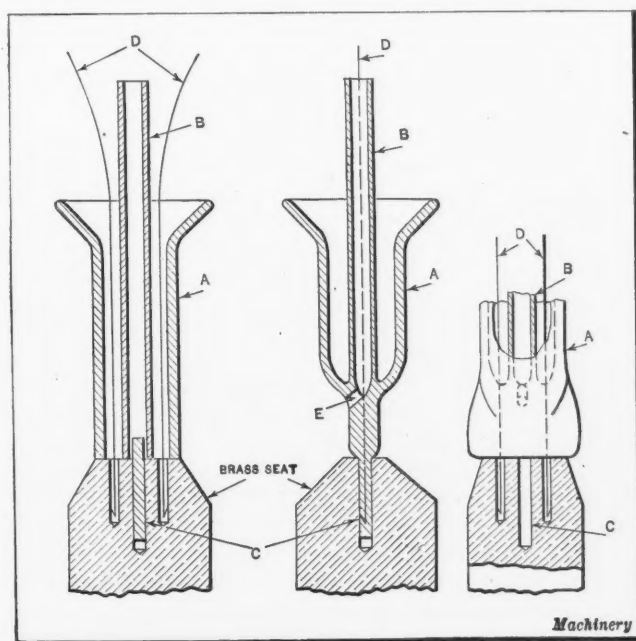

Fig. 2. Diagrammatic Views, showing Relative Position of the Lamp Parts before and after assembling

depression. When the top clamp is released from its back position, its movement is actuated by a light spring tension. When the clamp is in its forward position, jaw G must be withdrawn slightly, as previously stated, so as to clear the tube in loading.

The finger-lever and the clamps are arranged at the lower end so that they may be operated without the attendant removing his hand from the work-head, and in this way, he can hold the head from revolving while the work is being removed and new parts substituted. Jaw G holds the tube under light spring pressure. The projecting end of the melted-in tube is finally heated and cracked off, and in assembling into the base of the lamp it is embodied in the solder by means of which the base of the lamp is sealed.

* * *

Balsa, one of the commonest trees in the forests of Costa Rica, is said to be the lightest of all known woods, weighing but 7.3 pounds per cubic foot. Ordinary cork is three times as heavy as Balsa wood. This wood is very soft, and can be readily indented with the finger nail. It absorbs water readily, but it may be treated with paraffin, and then used in making floats for life preservers and in the construction of life rafts. It is also used for buoys and floating attachments to light signals.

MACHINERY WOULD REDUCE BUILDING WORKS

In a statement made by L. J. Horowitz, president of the Thompson-Starrett Co., it is pointed out that if machinery were introduced to take the place of manual labor, whenever possible, in building operations, it would bring down building costs. The high cost of building, says Mr. Horowitz, is directly due to the high wages paid at the building site and at the factories where building materials are produced, and is traceable to the lack of progress in the building industry in the development of improved methods and in the use of modern machinery. In the building industry alone, among leading industries, primitive methods still prevail. A man may be seen on his hands and knees troweling a cement floor to make it smooth when machines could be developed to do this work better, and when, with the assistance of such a machine, one man could do the work of ten.

Building costs could also be reduced by the more general use of modern machinery in the manufacturing of building materials; by a study of substitute materials which would serve the required purpose and be less costly; and finally by a study of present building codes, so as to eliminate the requirements which increase costs, but which are unnecessary from any point of view of usefulness or service.

* * *

APPRENTICE TRAINING IN THE WESTINGHOUSE COMPANY'S WORKS

A comprehensive booklet entitled "Trades Training" has recently been published by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. This booklet outlines briefly the requirements in the different trades in which apprentices are accepted by the Westinghouse Co. Thus the trade of the patternmaker, the machinist, the toolmaker, the electrician, and the printer are briefly outlined. The Westinghouse Co. maintains its own printing plant, and hence engages apprentices in the printing trade as well. In addition, there is an industrial apprentice course intended primarily for office boys, messengers, blueprint boys, and tool handlers. The boys in this course may be transferred to one of the regular trades' courses any time after their qualifications and ability have been determined. The apprentices are paid a very satisfactory scale of wages. Based upon the average number of working hours per month in the shop as being 203, the hourly rates paid for trade apprentices are as follows: 20 cents per hour for the first six months; and then for each following six months' period in the total four-year course the following rates are paid: 22 cents, 24 cents, 26 cents, 29 cents, 32 cents, 36 cents, and 41 cents, consecutively.

In addition to the regular trades' training, the company maintains what is known as an "Intermediate Training for High School Graduates," a booklet on which has also been published. This course covers two years, and includes training in the following subjects: General manufacture, drafting, clerical engineering work, sales correspondence, heat-treatment of metals, works accounting, planning and scheduling, inspection and testing, and service work. In this course the pay for the four consecutive six months' periods, basing the month upon 203 hours each, is as follows: 33 cents, 35 cents, 39 cents, and 44 cents per hour.

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REPORT ON INDUSTRIAL ACCIDENTS

The U. S. Bureau of Labor Statistics, Washington, D. C., has issued Bulletin No. 339, dealing with industrial accidents. About one-half of the report deals with statistical data relating to accidents, arranged, as far as possible, by uniform classification as to industries, cause of the injury, and nature of injury. The information in the report has been obtained from practically all parts of the United States.

Design of Punching and Shearing Machines

Designing the Gear, Pinion, Countershaft, Pulley, and Flywheel—Third Article of a Series

By A. LEWIS JENKINS, Professor of Mechanical Engineering, University of Cincinnati

THE gear and pinion on punching and shearing machines are made of cast iron, and the teeth are usually cut or machine-molded, although a great many gears having pattern-molded teeth are also used. The velocity ratio of the gears is such as will give from 20 to 40 revolutions per minute of the camshaft with a pulley speed of from 175 to 275 revolutions per minute. The pulleys on some small machines run slower and the camshaft faster than on larger machines, the gear ratios of the small machines being as low as 6 to 1, and of the large machines of the same type as high as 12 to 1. It is good practice to have the speed of the pulley and the gear ratio such as will give about $\left(\dfrac{5}{\sqrt{dt}} + 20\right)$ strokes of the punch per minute, where d = diameter of hole to be punched and t = thickness of plate.

The pinion should have as many teeth as conditions will permit in order to run quietly, but in many instances the gear will have to be very large unless a small pinion is used. The number of teeth in the pinion varies from 11 to 16, it being desirable to have at least 15 when conditions will permit. Three leading manufacturers of punching machines use for the gear and pinion, respectively, 90 and 12, 100 and 15, and 98 and 14, which give velocity ratios equal to 7.5 to 1, 6 2/3 to 1 and 7 to 1. Other numbers of teeth for the gear and pinion, respectively, have been 85 and 12, 95 and 15, 95 and 12, 97 and 12, 109 and 12, 120 and 12, 132 and 12, and 144 and 12.

The greater the ratio, the faster the pulley will have to run in order to give the desired number of strokes per minute, and as the flywheel is on the pulley shaft, it will easily be seen that a high gear ratio reduces the necessary width of belt and weight of flywheel. Although some designers prefer a constant ratio for all sizes of machines, it is advisable to use a ratio that will require a belt width of approximately $5.25\sqrt{dt}$. It is advisable to calculate the belt width by applying formulas that will be given later in connection with the design of pulleys.

Determining the Gear Tooth Proportions

For cut gears, the standard proportions of involute teeth may be used. In the formulas to be given,

P = diametral pitch; O = outside diameter;
C = circular pitch; T = thickness of tooth at pitch line;
A = addendum; H = total depth of tooth; and
D = pitch diameter; N = number of teeth.

According to the standard proportions for cut gears,

$$A = \frac{1}{P} = 0.3183C \qquad\qquad D = \frac{ON}{3.1416} = \frac{N}{P}$$

$$O = 2A + D = \frac{N+2}{P} \qquad\qquad H = \frac{2.157}{P} = 0.6886C$$

$$T = 0.5C$$

For gears with cast teeth, the following proportions may be used:

$$A = 0.3C \qquad\qquad H = 0.7C$$
$$O = D + 0.6C \qquad\qquad T = 0.48C$$

The twisting moment T_1 transmitted by the gear equals $T + T_2$, where T is the twisting moment on the camshaft produced in punching the hole, and T_2 is the twisting moment on the camshaft required to overcome friction. Twisting moment T_2 may be taken as equal to $0.15T$ which gives

$$T_1 = 1.15T$$

The Lewis formula for the design of spur gear teeth, which is the most satisfactory, is as follows:

$$W = SFCY$$

W = load transmitted by teeth, in pounds;
F = width of face, in inches;
C = circular pitch;
Y = outline factor = $0.124 - \dfrac{0.684}{N}$ for 14½-degree involute and cycloidal teeth, N representing number of teeth in gear; and
S = safe working stress, which varies with the velocity.

In using this formula, it is necessary to determine the velocity at the pitch line of the teeth in order to find value S. Carl G. Barth found that the velocity could be introduced in the formula by writing it in the form

$$W = SFCY\left(\frac{600}{600 + V}\right)$$

in which

V = velocity, in feet per minute, at the pitch line; and
S = a constant equal to 8000 for cast-iron teeth and 15,000 for cast-steel teeth.

For cut gears, S may be as great as 12,000 for cast-iron and 20,000 for steel castings. In this formula, S is known and Y may be found from the assumed number of teeth, but F, C, and W are unknown, and it is necessary to solve by trial or substitute values of W and V and treat the formula in the following manner:

Let R = pitch radius of gear, in inches;
   n = number of teeth in pinion;
   v = velocity ratio of gears = $N \div n$;
   f = ratio of face width to circular pitch or $F \div C$;
   q = revolutions per minute of pinion.

Then

$$W = \frac{T_1}{R} = \frac{T_1}{NC \div (2 \times 3.1416)} = \frac{2 \times 3.1416T_1}{NC}$$

and

$$V = \frac{Cnq}{12} = \frac{CNq}{12v}$$

Substituting these values in the foregoing formula,

$$\frac{2 \times 3.1416T_1}{NC} = \frac{SfC^2Y600}{600 + (Cnq \div 12)}$$

$$SfNYC^3 - 0.000874T_1nqC = 6.28T_1$$

By assuming $v = 3$ to 4, all the values in this equation are known except C, which may be found by a trial solution of the cubic equation.

The circular pitch is sometimes made equal to the travel of the slide, and the width of face varied to satisfy the Lewis formula. This does not give very satisfactory results unless the velocity ratio and number of teeth happen to be properly chosen. In designing medium-sized machines, it is desirable to keep the bottom of the flywheel above the floor line. Assuming that the lower jaw is 30

inches above the floor line and the diameter of the flywheel 0.8 times the diameter of the gear, the latter should not exceed $9\sqrt[3]{dt} + 12\sqrt{dt} + 40$. On large machines, the bottom of the pulley may be near the floor, but in order to have sufficient space for the back stand and clearance bebetween the back stand and pulley, it is desirable to have the diameter of the gear not exceed $18\sqrt[3]{dt} + 10\sqrt{dt} + 40$.

Shrouding the Gear and Pinion to Increase their Strength

Gears on very large machines are often shrouded about half the height of the tooth, and the pinion is made of steel and similarly shrouded. If the load, pitch, face, and velocity are kept constant, the effect of changing the number of teeth is expressed by the equation:

$$\frac{S}{S_1} = \frac{Y_1}{Y} = \frac{N\,(0.124n - 0.684)}{n\,(0.124N - 0.684)}$$

in which S and S_1 are the allowable unit stress in the gear and pinion, respectively; Y and Y_1, the outline factor for the gear and pinion, respectively; N, the number of teeth in the gear; and n, the number of teeth in the pinion. For example, suppose the stress in a 100-tooth gear is 8000 pounds per square inch and that it is desired to know the stress in a 12-tooth pinion having an equal width of face and transmitting the same load at the pitch line. Substi-
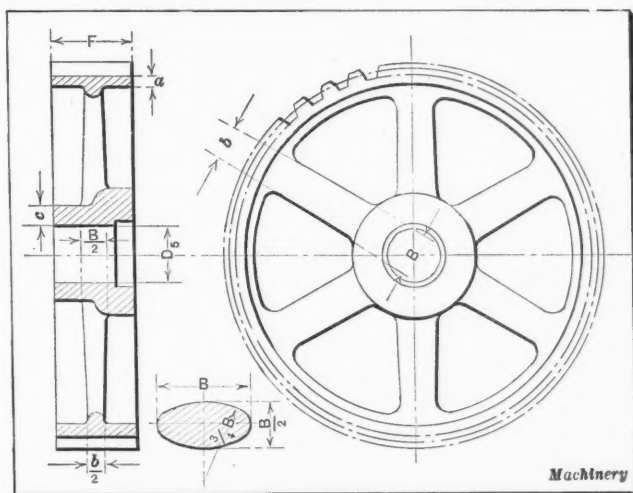

Fig. 1. Design of Gear employed on Punching and Shearing Machines

tuting the known values in the foregoing equation we have:

$$\frac{8000}{S_1} = \frac{0.067}{0.118} \text{ and } S_1 = 14{,}100 \text{ pounds per square inch}$$

Unless the pinion is made of steel or shrouded, this value for the stress is excessive. It is desirable, however, to have the pinion the weakest member in the machine so that it will break before the frame or any other member becomes critically stressed. The cost of replacing a broken pinion is negligible whereas the cost of repairing a machine with a broken frame is comparable with the price of a new one. It is, therefore, desirable to have the pinion only strong enough to perform its duty under normal working conditions and to fail under an appreciable overload. This may be accomplished by having a working stress on a cast-iron pinion of from 11,000 to 12,000 pounds per square inch.

Shrouding the pinion to the outside diameter on both sides increases its strength about 50 per cent, and shrouding it to the pitch line on both sides, or to the outside on one side, increases its strength about 25 per cent. In the case mentioned, the stress of 14,100 pounds per square inch in the unshrouded pinion might be reduced to $14{,}100 \div 1.25$ $= 11{,}300$ pounds per square inch by shrouding to the outside diameter on one side or to the pitch diameter on both sides, and this stress would be sufficiently high to cause the pinion to fail before other elements of the machine became overstrained. If the pinion is shrouded on both sides, the

width of the face should be about ¼ inch greater than the width of the gear face, to allow clearance between the teeth on the gear and the shroud on the pinion. The thickness of the shroud is made equal to the thickness of the teeth at the pitch line.

The Rim, Boss, and Arms of the Gear

Thickness a of the rim in Fig. 1 varies from $0.5C$ to $1.25C$. It is good practice to make it equal to the height of the tooth or $0.7C$. The gear should have six elliptical-section arms, the major axis B being equal in length to twice the minor axis. The arms are considered as cantilever beams fixed at the boss and free at the rim ends. The sum of the bending moments on all of the arms is equal to the twisting moment on the shaft. The stress s due to bending should not exceed 4000 pounds per square inch, and it is assumed that half of the arms carry the load. The bending moment M on each arm is:

$$M = \frac{2T_1}{6}$$

and the resisting moment for such a section is $0.05B^3s$. Hence,
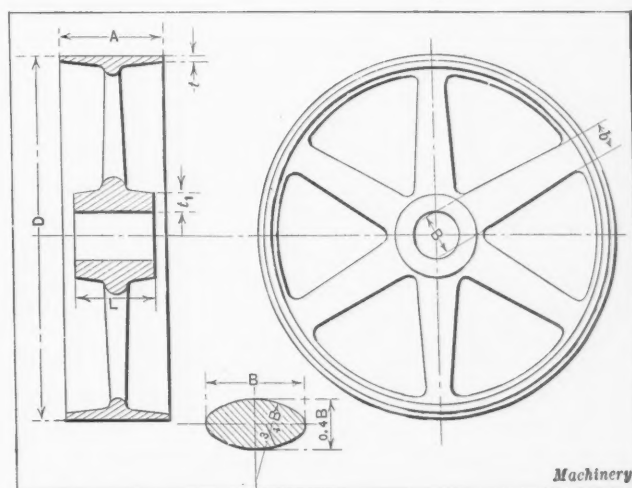
$$\frac{T_1}{3} = 0.5B^3s$$

Fig. 2. Drawing illustrating the Proportions of the Driving Pulley

and

$$B = \sqrt[3]{\frac{T_1}{3 \times 0.05 \times 4000}} = 0.1185\sqrt[3]{T_1}$$

This value B is the breadth of the arm when produced to the axis of the gear. The breadth of the arm produced to the pitch line is $b = 0.66B$.

The thickness of the boss may be found by the formula

$$c = 0.4B + 0.4$$

This value applies only to one end of the boss, the diameter of the other end depending upon the outside diameter of the clutch. In case the sum of D_5 (which was determined in the second article of this series) and $2c$ is greater than the outside diameter of the clutch, the diameter of the boss should be the same throughout and equal to the outside diameter of the clutch. The length of the boss from the outside of the clutch may be made equal to about twice the diameter of the shaft at the gear.

Formula for Countershaft Diameter

The countershaft is subjected to three loads, namely, the force exerted at the pitch circle of the pinion, the pull of the belt, and the weight of the flywheel. These forces are not parallel, and the direction of the pull on the belt is not definite; hence, the effect of the bending cannot be accurately determined. If the bending moment could be determined with accuracy, the working stress
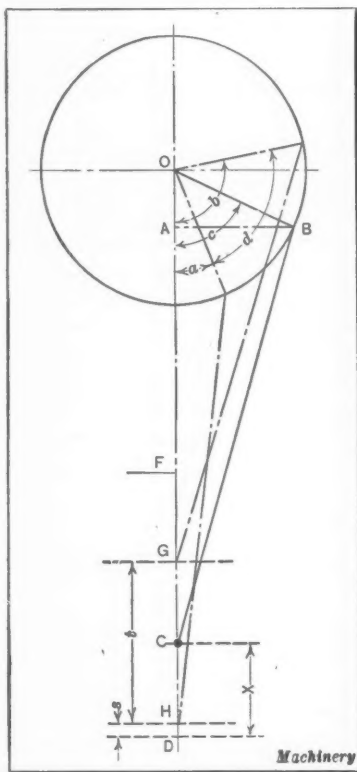
Fig. 3. Angular Positions of the Eccentric and Pendulum in punching the Hole

should equal about 11,-000 pounds per square inch; but as the weight of the flywheel acts near the outer bearing and the force from the gear acts near the bearing on the frame, the bending moment is small compared with the twisting moment. By neglecting the bending and allowing a unit working stress of 8000 pounds per square inch in the formula for the diameter of a shaft subjected to torsion.

$$D = \sqrt[3]{\frac{5.1T_2}{8000}}$$

in which $D =$ diameter of countershaft, and T_2 = twisting moment on countershaft, which is equal to the force at the pitch circle of the pinion times its pitch radius. If the twisting moment on the gear is used in the preceding formula, it should be divided by the gear ratio; or

$$D = \sqrt[3]{\frac{5.1T_1}{8000v}}$$

in which T_1 is the twisting moment on the gear, and v the velocity ratio of the gears.

Diameter of Pulley and Width of Belt

The diameter of the driving pulley varies from 10 to 40 inches, depending more upon the size of the frame and the general outline of the machine than the rules for economical belt speeds. The diameter may be found by the empirical formula

$$D = 11\sqrt{dt} + 7$$

to the nearest even number, such as 10, 12, 14, 40, etc. The number of revolutions per minute varies from 175 to 275, and the linear velocity of the belt from 700 to 2800 feet per minute. These depend upon the number of punch strokes per minute, the velocity ratio of the gears and the diameter of the pulley.

The speed of the driving pulley should be such as to give from 20 to 40 or $\dfrac{5}{\sqrt{dt}} + 20$ revolutions per minute of the camshaft, which means that the speed of the driving pulley depends upon the gear ratio and the size of the machine. One manufacturer uses a constant gear ratio of 7 to 1, and pulley speeds varying from 175 to 200 revolutions per minute, while another uses a ratio of 7.9 to 1, and speeds varying from 200 to 250 revolutions per minute.

The work done in punching a hole may be taken as equal to $3.1416 \times 60,000dt \times 0.5t$ inch-pounds. If the machine is to run continuously, this amount of energy must be supplied by the belt during one cycle of the slide operation or in one revolution of the camshaft.

Let $P =$ effective pull of belt on pulley per inch of width;

$v =$ velocity ratio of gears; and

$w =$ width of belt, in inches.

Then during one cycle of the machine operation, the rim of the pulley passes through $3.1416Dv$ inches, and the work done is equal to $3.1416\, DvPw$ inch-pounds. Equating

this with the work required to punch the hole, and solving for the width of belt we have:

$$w = \frac{30,000dt^2}{DPv}$$

The effective pull of the belt per inch of width varies with the thickness of the plate and should be considered equal to about $45\sqrt{dt}$ for double belting and $30\sqrt{dt}$ for single belting. Then, for double belts,

$$w = \frac{670dt^2}{Dv\sqrt{dt}}$$

and for single belts,

$$w = \frac{1000\, dt^2}{Dv\sqrt{dt}}$$

The value v used in these formulas should be such as will give a width of belt approximately equal to

$$w = 5.25 \sqrt{dt}$$

Single belts may be used on machines smaller than one having a capacity for punching a $\frac{7}{8}$-inch hole through $\frac{7}{8}$-inch plate. Width A of the pulley face as shown in Fig. 2, is as follows:

$$A = w + 0.25 \text{ to } w + 0.5$$

It is not necessary to crown the faces of the tight and loose pulleys when a belt shifter is used. Thickness t of the rim for single belts may be made equal to

$$t = \frac{D}{200} + \frac{1}{8}$$

For double belts,

$$t = \frac{D}{200} + \frac{1}{4}$$

The inside of the rim should have a taper of about $\frac{1}{2}$ inch per foot to allow the pattern to be easily drawn from the mold.

Dimensions of Pulley Arms

The arms may be proportioned by making the breadth equal to 0.4 times the depth; and allowing for the maximum force transmitted by the belt, 60 pounds per inch of width for single belts, and 120 pounds for double belts, and a working stress for cast iron equal to 4500 pounds per square inch. Then, proceeding as in deriving the formula for the breadth of arms on gears, we have for single belts,

$$B = 0.692 \sqrt[3]{\frac{wD}{n}}$$

For double belts,

$$B = 0.87 \sqrt[3]{\frac{wD}{n}}$$

where $n =$ number of arms. The thickness of the boss for single belts may be found by the formula,

$$t_1 = 0.14 \sqrt[3]{AD} + 0.25$$

For double belts,

$$t_1 = 0.18 \sqrt[3]{AD} + 0.25$$

Length L of the boss on the loose pulley should equal $A + 1.5$, and for the tight pulley, L should equal $0.5A + 1.375$.

Relation between Travel of Slide and Angle Turned Through by Camshaft

Before designing the flywheel, it is necessary to know the angle turned through by the camshaft while the punch is going through the plate. This angle will now be considered. A diagram of the crank mechanism for operating the slide is shown in Fig. 3, where DF represents the travel of point C during one revolution of the eccentric, point C being the lower end of the pendulum or connecting-rod. This travel is equal to twice the eccentricity OB. On the downward stroke, the punch strikes the plate at G,

passes through it at H and into the die a distance HD. When the crank is on the lower dead center, point C coincides with point D. By moving the crank through an angle c, point C moves up a distance DC or length X. To find distance DC in terms of angle c, radius OB, and length BC and the angularity of the crank positions when point C is at G and H, respectively, let

e = radius of crank or eccentricity OB;
L = length of connecting-rod or pendulum BC;
s = distance punch enters die DH;
X = distance CD;
a = crank angle when punch leaves plate;
b = crank angle when punch enters plate; and
d = angle turned through by camshaft while punch is going through plate.

When the crank has turned through any angle c from the lower dead-center position, the distance the slide will have moved through is as follows:

$$X = DO - CO = DO - (CA + AO)$$

It is evident that $DO = L + e$. Then

$$AO = e \cos c$$
$$AB^2 = e^2 - AO^2 = L^2 - CA^2$$
$$CA = \sqrt{AO^2 + L^2 - e^2} = \sqrt{(e \cos c)^2 + L^2 - e^2}$$

Now substituting these values of DO, AO, and CA in the equation for X, gives us

$$X = L + e - (e \cos c) - \sqrt{(e \cos c)^2 + L^2 - e^2}$$

This equation gives the position of the slide for any crank position. In designing the flywheel, it is desirable to have the preceding equation solved for angle c instead of distance X. To do this, it is expedient to let $K = L + e$, $M = e \cos c$ and $N = L^2 - e^2$. Substituting these values in the foregoing equation,

$$X = K - M - \sqrt{M^2 + N}$$
$$K - M - X = \sqrt{M^2 + N}$$
$$(K - M - X)^2 = M^2 + N$$
$$(K - X)^2 - 2M(K - X) + M^2 = M^2 + N$$
$$M = \frac{(K - X)^2 - N}{2(K - X)} = \frac{1}{2}\left(K - X - \frac{N}{K - X}\right)$$

By substituting the original values of K, M, and N, we have:

$$e \cos c = \frac{1}{2}\left(L + e - X - \frac{L^2 - e^2}{L + e - X}\right)$$
$$\cos c = \frac{1}{2e}\left(L + e - X - \frac{L^2 - e^2}{L + e - X}\right)$$

When $X = s$, angle c = angle a, and when $X = s + t$, angle c = angle b.

Hence

$$\cos a = \frac{1}{2e}\left(L + e - s - \frac{L^2 - e^2}{L + e - s}\right)$$

and

$$\cos b = \frac{1}{2e}\left[L + e - (s + t) - \frac{L^2 - e^2}{L + e - (s + t)}\right]$$

Angle d turned through by the camshaft while the punch is passing through the plate equals angle b minus angle a.

Calculating the Flywheel

The function of the flywheel on a punching machine is to store up kinetic energy during that portion of the cycle in which the machine is not acting on the plate and give out this energy while punching the hole. The energy expended in punching the hole depends upon the depth of penetration and the resistance of the metal, and can only be determined accurately from a curve showing the relation between the load and the travel of the punch. Such a curve can be drawn by an autographic recorder on a testing machine. There is no great error, however, in as-suming that the mean force is one-half of the maximum force. Then the work done is equal to the maximum force required to punch the hole times one-half the plate thickness. Let

W = weight of flywheel rim, in pounds;
E = energy required to punch hole;
E_1 = energy delivered to machine by belt while punch is going through plate;
E_2 = energy given out by flywheel while punch is going through plate;
w = width of belt, in inches;
D = mean diameter of flywheel rim, in inches;
D_1 = diameter of driving pulley, in inches;
P = effective pull on belt, in pounds per inch of width;
v = velocity ratio of gears;
d = angle turned through by camshaft while punch is going through plate (see Fig. 3);
V = normal linear velocity of a point on mean diameter D of flywheel, in feet per second;
V_1 = linear velocity of a point on mean diameter D, in feet per second, after punch passes through plate;
g = acceleration due to gravity; and
q = revolutions per minute of driving pulley and flywheel.

Designating the angle turned through by the flywheel while the punch is going through the plate as vd, the energy, in inch-pounds, received from the belt during this period may be determined from the formula:

$$E_1 = \frac{3.1416 P D_1 w v d}{360}$$

The energy, in inch-pounds, required to punch the hole, is:

$$E = 3.1416 dt \times 60,000 \times 0.5t = 94,250 \, dt^2$$

The energy, in inch-pounds, that must be given out by the flywheel in punching the hole, is:

$$E_2 = E - E_1 = 94,250 dt^2 - \frac{3.1416 P D_1 w v d}{360}$$

This result is divided by 12 to find energy E_2, in foot-pounds.

The total kinetic energy, in foot-pounds of the flywheel when the punch enters the plate is $\dfrac{WV^2}{2g}$. Owing to the decrease in velocity, this energy is decreased to $\dfrac{WV_1^2}{2g}$ when the punch leaves the plate. Hence the energy given out by the flywheel in punching the hole is that due to the change in velocity from V to V_1, which is expressed by the equation:

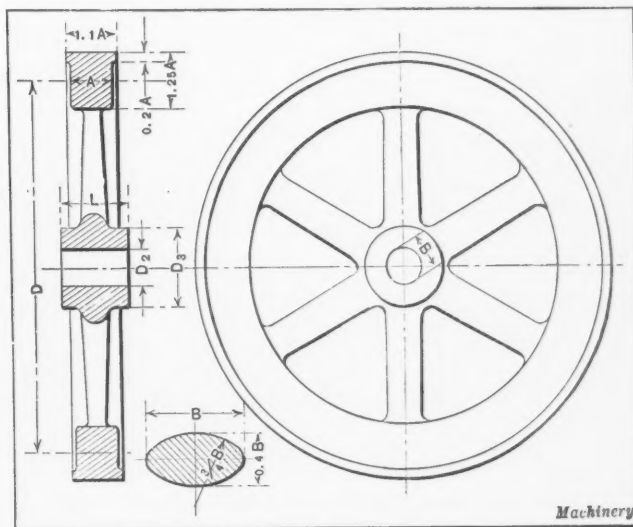$$E_2 = W \times \frac{(V^2 - V_1^2)}{2g}$$

Fig. 4. Diagram used in calculating the Flywheel Dimensions

The normal velocity of the flywheel, in feet per second, may be found by the formula

$$V = \frac{3.1416 Dq}{12 \times 60}$$

In deciding on the mean diameter of the flywheel rim, it would be most economical to use a constant linear velocity of about 4000 feet per minute. This would fix the diameter of the flywheel for a machine with a given pulley speed, but would give absurd results on some machines. The only rule that can be safely followed is to make the flywheel of such diameter as will harmonize with the frame, and, if possible, not extend below the floor line. In most cases the diameter of the flywheel may be made from 0.8 to 1 times the diameter of the gear.

There are two methods of determining the weight of the flywheel when the energy required to punch the hole and the normal velocity are known:

1. Assume that the flywheel should have sufficient kinetic energy when running at the normal velocity to punch two holes. On this assumption, the weight may be found by the formula:

$$W = \frac{15,700 dt^2 \times 2g}{V^2} = \frac{31,400 g dt^2}{V^2}$$

2. Assume that the rim of the flywheel should have sufficient weight to satisfy the equation $E_2 = \dfrac{W(V^2 - V_1^2)}{2g}$ when the variation in the velocity is 20 per cent, or $V_1 = 0.8V$. Then,

$$V^2 - V_1^2 = V^2 - 0.64V^2 = 0.36V^2$$

and

$$W = \frac{2E_2 g}{0.36 V^2} = \frac{E_2 g}{0.18 V^2}$$

The kinetic energy of the arms and the boss is so small, compared with that of the rim, that it may be neglected. Also, the depth of the rim is so small, compared with the diameter, that the radius of gyration is practically equal to the mean radius of the rim.

The proportions of the flywheel rim and arms are shown in Fig. 4. The area of a rim section, in square inches, equals $(A \times 1.25A) + (0.1A \times 0.2A) = 1.27A^2$, while the volume of the rim, in cubic inches, equals approximately $3.1416D \times 1.27A^2$, cubic inches. As a cubic inch of cast iron weighs about 0.26 pound, the weight of the rim equals $3.1416D \times 1.27A^2 \times 0.26$ pound. Equating this formula for the weight with that given in method (1) gives

$$\frac{31,400 \times g dt^2}{V^2} = 3.1416D \times 1.27A^2 \times 0.26$$

and

$$A = 987 \times \frac{t}{v} \sqrt{\frac{d}{D}}$$

Also, substituting in the formula for weight given in method (2),

$$\frac{E_2 g}{0.18 V^2} = 3.1416D \times 1.27\ A^2 \times 0.26 \text{ or } A = \frac{13.15}{V} = \sqrt{\frac{E_2}{D}}$$

The energy of the flywheel is transmitted to the driving shaft through the arms, and so they should not have sufficient strength to exert a twisting moment that would produce failure or serious distortion of the shaft. The twisting moment on the shaft is equal to $\dfrac{D_2^3 S}{5.1}$ in which S_s is the unit shearing stress. The bending moment on each of the six arms is $\dfrac{D_2^3 S_s}{30.6}$, and the resisting moment is equal to $0.05B^3 S$, where S is the normal stress due to bending, and B the major axis of the elliptical arms; hence $\dfrac{D_2^3 S_s}{30.6} = 0.05B^3 S$, and

$B = D_2 \sqrt[3]{\dfrac{S_s}{1.53 S}}$. Assuming that the ratio of S_s for steel to S for cast iron is 4 to 1, this formula reduces to $B = 1.38 D_2$. This ratio of stresses will allow the arms of the flywheel to fail before the shaft breaks or distorts sufficiently to injure the gears or bearings. The section of the arms may be the same throughout their length or may be tapered, the same as for the gear. Length L of the boss may be from $1.5D_2$ to $1.75D_2$. Diameter D_3 of the boss may be from $2D_2$ to $2.5D_2$.

* * *

DEVICE FOR HAND-REAMING BUSHINGS

By R. GUSTAFSON

The equipment, shown in the accompanying illustration, for finish-reaming bushings by hand has proved very satisfactory. As every mechanic knows, it is a troublesome job to hold a bushing in a vise without a special fixture designed to prevent the bushing from collapsing. If the procedure is reversed, the reamer being gripped in the vise and a pipe
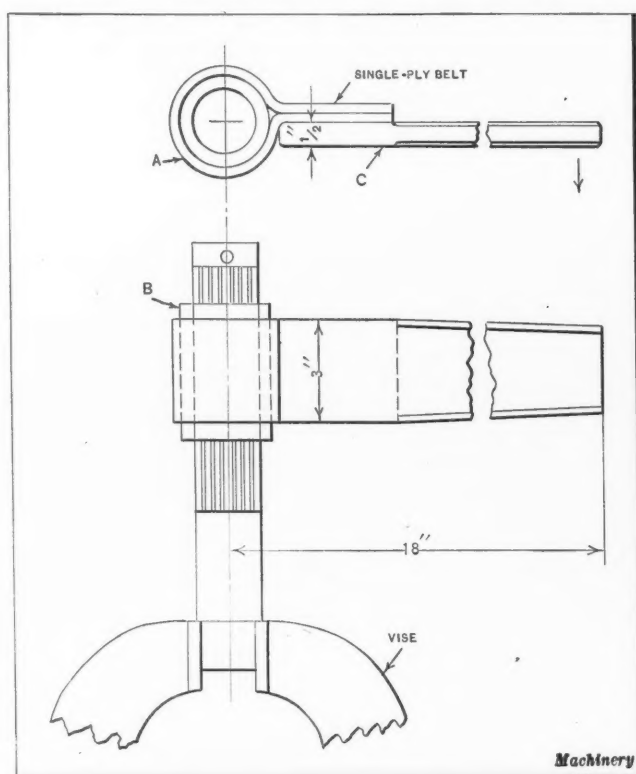
Equipment for hand-reaming Bushings

wrench or other tool used to turn the bushing on the reamer, the outer surface of the bushing will be marred or burred.

The tool shown eliminates this trouble. It is made from a piece of belting A, which is fastened to a handle C. By making the loop formed by the belting a close fit on bushing B, a very good grip will be obtained when handle C is pulled in the direction indicated by the arrow. A device of the size indicated by the dimensions given is about right for finish-reaming brass bushings having an inside diameter of 2 inches, an outside diameter of $2\frac{1}{2}$ inches, and a length of not more than 6 inches.

* * *

The British Non-ferrous Metals Research Association has undertaken an extensive series of investigations on die-casting alloys which will spread over a period of at least three years and for which an expenditure exceeding $50,000 will be made. Full particulars about these investigations may be obtained from the headquarters of the association, 71 Templerow, Birmingham, England. The research has been divided into three sections dealing, respectively, with brass and bronze alloys; aluminum alloys; and low melting-point alloys (zinc, tin, lead, etc.)

FINISHING AIRPLANE ENGINE CAMS

On a certain type of rotary airplane engine, both the intake and the exhaust valves are operated by a double cam, the lobes on each face of which are arranged to operate the valves successively. These cams are made of chrome-nickel steel, and provided with an internal gear. The methods employed in turning and grinding the periphery of the cams are described in the following.

The lathe in which the turning is performed is equipped with a special chucking arrangement and a master cam for guiding the turning tool over the lobes, as shown in Fig. 1. It is important that a definite relation exist between a particular tooth on the internal gear and the cam lobe, so, in chucking, the cams are located by two dowel-pins which engage the flanks of diametrically opposed teeth. The dowel-pins are carried in a plate which is removable from the chuck so that it can subsequently be used as a jig-plate in drilling nine holes in the cam. These holes must all be
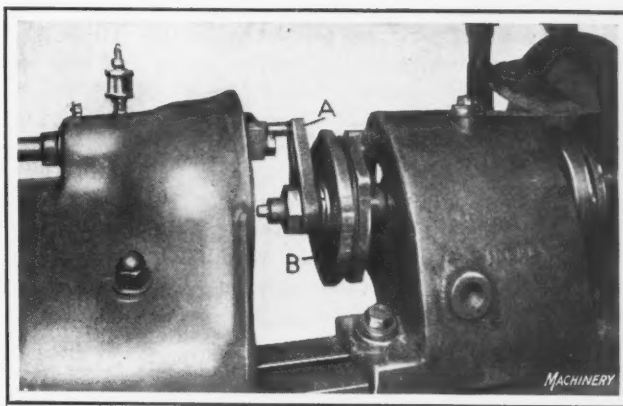

Fig. 2. Work-head which permits the Grinder Spindle to rock in Conformity with the Contour of a Master Cam

Views of this machine are shown in Figs. 2 and 3. The driving plate of the work-head, Fig. 2, is driven by a pulley of large diameter (shown in Fig. 3) at four revolutions per minute. There is an internal gear on the inner side of the plate meshing with a pinion on the pulley shaft. The large pulley is driven from the regular driving shaft extending through the base of the machine, by a pulley 1½ inches in diameter, instead of by the regular pulley furnished with the machine. The diameter ratio of these two pulleys is so great that it has been found necessary to knurl the face of the small pulley and use a weighted idler to maintain the necessary driving tension on the belt.

The spindle carrying the driving arm A, Fig. 2, which also carries the master cam at one end and the work at the other, is mounted in bearings that are capable of swinging but that do not swing except as the master cam B revolves over a roll at the rear. This roll can be reversed for engaging either periphery of the cam. The roll is kept in contact with the master cam by means of a weight hung at the rear. It is important that the radius of this cam roll be the same as that of the grinding wheel, and both should correspond to the radii joining the cam and lobes. The grinding wheel should not be allowed to wear down much before being replaced by a new one; otherwise the contact of the wheel and the cam roll would not be alike on corresponding lobes. The radius of the lobe is 1 1/16 inches.

The regular wheel-head of the machine is set back, and in its place is mounted an auxiliary grinding-wheel spindle A, Fig. 3, taken from a Landis internal grinder. This spindle is driven from the regular spindle by a belt, and is located correctly to bring the periphery of the wheel tangent with that of the cam. The spindle mounting is supported on a bracket or arm extending forward from the

Fig. 1. Turning Airplane Engine Cams on a Specially Equipped Lathe

drilled in the same relative position in order to maintain balance. The tooth used to locate the cam for turning is marked so that it can also be used for locating in the drill jig plate. After the cam has been located for turning by the two pins, another plate is clamped against the outer side of the cam.

The master cam shoe is carried in a vertical post on the carriage and is moved from one face of the master cam to the other as required. This post is reinforced by a turnbuckle brace for adjusting for spring caused by the thrust of the shoe in passing over the cam lobes. There is a 150-pound weight at the rear of the lathe, which keeps the shoe in contact with the master cam. The tool is prevented from digging into the periphery as it passes over the lobes by hanging another weight to the spindle brake-lever, situated directly in back of the faceplate. This produces a constant break action, and prevents the tool from jumping ahead as it passes from the lobe. In turning, 0.020 inch of metal is allowed for grinding after the cams have been casehardened.

A Landis cylindrical grinder with a special work-head and an auxiliary grinding wheel head is used for the grinding operation.
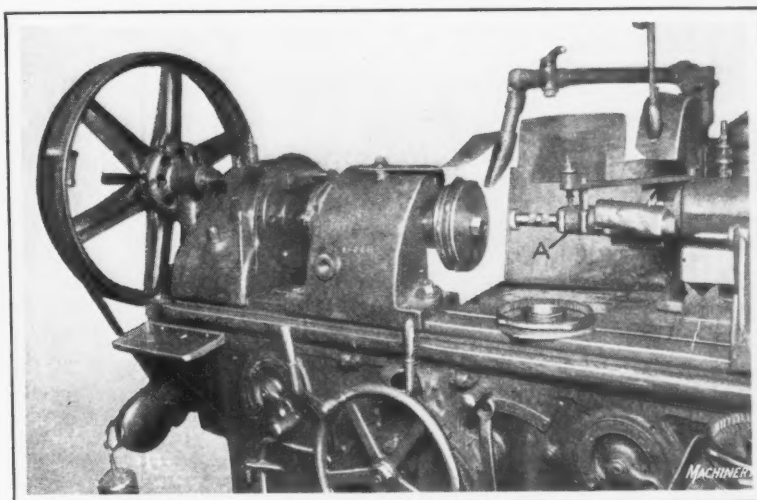

Fig. 3. Cylindrical Grinding Machine Adapted for grinding the Periphery of Airplane Engine Cams

regular wheel-head, and is properly braced. As previously stated, the wheel must be kept close to size, although a little wear will not affect the relative position of roll and wheel to any appreciable degree. The grinding wheel is 2⅛ inches in diameter, and it is operated at a speed of 6000 revolutions per minute.

Nine ¾-inch holes are then drilled to lighten the cam, using the locating plate which is a part of the turning chuck, as previously mentioned. During this operation the cam is laid flat on the drilling machine table with the plate located inside it.

* * *

METHOD OF CUTTING INTERNAL THREADS

By CHESMAN A. LEE

The method of cutting internal threads on a lathe described in the following was originated and used by the writer in the production of various machine parts. This method gave excellent results, and it is believed that it will be of interest to many machinists. In common with most shop men, it is the writer's practice, in cutting external threads, to set the compound rest at an angle of 60 degrees, and feed the cutter in along one side of the thread, as indicated by arrow A in Fig. 1. This practice results in cutting only on the left-hand side of the thread.

Many machinists, in cutting internal threads, set the compound rest to an angle of 60 degrees in the direction opposite to that used for external threads, and feed the tool to the required depth in the direction indicated by arrow B. Thus the tool cuts on the left side only, as in the case of the external thread. The left-hand side of the tool, is, of course, the advancing side as it travels along the work. With this method the tool can be given a large top rake, so that it will cut very freely. Internal threads cannot, however, be cut so fast as external threads, as the tool has a tendency to chatter and gouge if heavy feeds are attempted.

In order to speed up internal threading operations, the writer had the top rake reversed on the threading tool, so that it would cut on the rear side of the thread as the tool travels in the direction indicated by arrow C. The compound rest was then, of course, set the same as for external threading. The arrow D indicates the direction in which the tool is fed to obtain the correct thread depth.

When the tool has reached the end of the first cut (traversing toward the headstock), the cross-slide is fed in so that the tool will clear the work. The lathe is reversed and the compound slide rest fed out in the direction of arrow D while the tool is being returned to the starting point for another cut. When the lathe is being reversed by the operator's right hand for the second cut, the cross-slide is fed straight out by the operator's left hand to the same point as
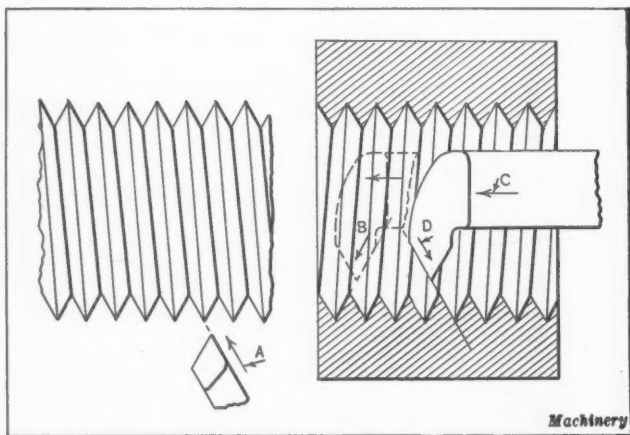

Fig. 1. Diagram used to illustrate Method of Cutting Internal Threads

was indicated by the dial when the first cut was taken. This new method of cutting internal threads gave excellent results, and was used in threading a lot of 100 eight-pitch 4-inch diameter pressed-steel nuts, taking seven cuts for each thread. The back-gears were disengaged and the spindle driven direct from the countershaft for this threading job. The cutting speed was about 120 feet per minute, so that the chips were smoking hot when they fell from the work. The steel used for the threading tool was "Rex AA." Of course the secret of the success of this method is that the tool cuts on the under side of a right-hand thread, so that the tendency is for the tool to spring out of the cut instead of gouging in when heavy cuts are taken.

Fig. 2. End View of Tool, Showing Heavy Shank

The resulting thread is smooth on both sides, although the feed marks show on the left-hand side of the thread groove. The tool is so ground and set that the cutting edge is in a horizontal plane that passes through the center of the lathe spindle. The rake given to the cutter, of course, brings the other edge below the center line. The included angle is made several degrees less than 60 degrees, and the compound rest is set exactly at 60 degrees, so that one side of the thread groove is cut to the correct angle, while the other is formed by setting the tool so that the cutting edge is at exactly 60 degrees with the center line of the work. The best results were obtained by having the threading tools forged to the shape shown in Fig. 2, which most tools attain only after they have been ground down. This permits the use of a heavy shank which gives greater rigidity.

* * *

BUSINESS FUNDAMENTALS FOR INDUSTRIAL EMPLOYES

A strong appeal for the education of industrial employes in the fundamentals of business economies and in the details of the business in which they are employed is made by Carl F. Dietz, president of the Bridgeport Brass Co., in a pamphlet recently issued by the Chamber of Commerce of the United States. At the plant of the Bridgeport Brass Co. the employes are educated through lectures and by means of simple illustrations. Mr. Dietz points out that one of the great benefits of this education has been that it is very effective in counteracting the misinformation and propaganda that is spread broadcast by people who are either misinformed themselves or who misinform others for purposes of their own.

The educational work also increases the interest of workers who perform certain operations on materials before they reach an advanced stage of completion. Usually these workers can have but little interest in their work, because they never see either the start or the finish of the job on which they are employed. "There is manifest at all times," declares Mr. Dietz, a "real desire on the worker's part to know more about the business in which he is employed. Far-seeing managers are seeking the best methods of imparting such information constructively, especially information on the relation of production to wages, and the distribution of the dollar received for the product of the plant."

* * *

The production of iron and steel in France increased considerably during the spring months, and on June 1 there were 99 furnaces operating, with 74 more ready to be blown in, the gain in production being chiefly in Lorraine.
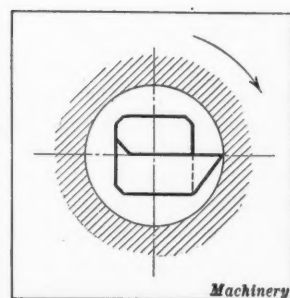
High-speed Motors for Machine Tools

By W. A. FURST, General Engineer, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

THE importance to the machine tool industry of the development of the high-speed induction motor for direct application to machine tools can hardly be over-estimated. Moderate and high-speed motors are now being applied to the same machine, the high-speed motor generally being used to drive the cutting tool, and the slower speed motor to drive the feeding mechanism. In most applications of this kind, the motor manufacturers furnish the machine tool builder with what is known as a shaftless type motor, which consists of the rotor and stator only, the machine tool builders supplying the bearings, shaft, and housing, in other words, the motor is built in as an integral part of the machine.

The many difficulties encountered in using high-speed belts have long been recognized, but the methods employed in the past to eliminate these troubles have not proved entirely practical. The high-speed, alternating-current motor for direct application has made possible the solution of this complex problem by the complete elimination of belts, thus increasing the efficiency of the machine tool and greatly lessening the possibility of injuring the operator.

When the ordinary standard alternating-current motor is mentioned, one naturally thinks of a motor operating on a 60-, 50-, or 25-cycle circuit. It might be well at this time to give a definition of the term "cycle." This term, as applied to alternating current, refers to that period of time in which the current builds up from zero to its maximum, then drops gradually back to zero, and passes through the same increase and decrease in the opposite direction. Thus there are two alternations for each cycle. By the "number of cycles," this is, 60, 50, or 25, is meant the number of complete cycles per second. In other words, for a 60-cycle line there are $60 \times 60 \times 2 = 7200$ alternations per minute. To obtain the various motor speeds, the motors are built with different numbers of poles. For all practical purposes, the number of poles used ranges from 2 to the upper limit of 18. For the smaller sized motors, it is not desirable to have a large number of poles, as it makes the cost prohibitive.

Factors that Determine Motor Speed

The high-speed motors are of the same construction as the standard squirrel cage motors. The speed of these motors ranges from 3600 to 18,000 revolutions per minute. Up to the present time 18,000 revolutions per minute has been the highest speed required as a commercial proposition. However, it is quite feasible to obtain higher speeds,

and motor manufacturers are prepared to build such motors for special applications. By referring to chart No. 1, the speed for two-, four-, six-, and eight-pole motors at various frequencies can be readily obtained. Locating the given frequency in the left-hand column, we follow the horizontal line from this point to the point where it intersects the diagonal line marked "2-pole" if the motor has two poles, or to the line marked "4-pole" if it has four poles. From the point of intersection of these lines we follow the vertical line downward to the bottom column, where the speed in revolutions per minute is read. For example, it will be found, by referring to the chart, that a two-pole motor operating on a 120-cycle line will run at about 7200 revolutions per minute; the same motor operating at 200 cycles will have a speed of 12,000 revolutions per minute.
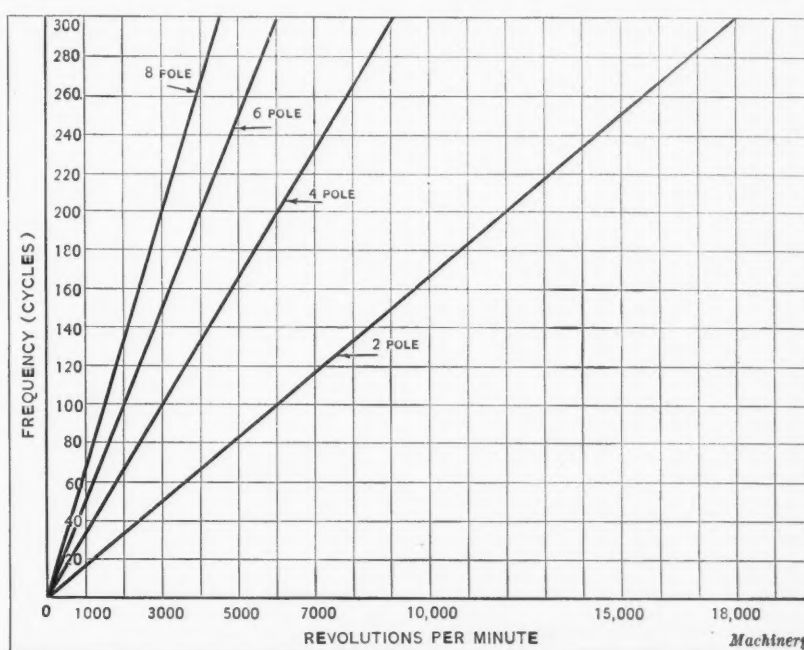
The speeds given in chart No. 1 are the synchronous or "no load" speeds. The drop in speed of an induction motor from no load to full load, or "the slip" as it is commonly called, is proportional to the amount of resistance in the rotor or rotating circuit. As the starting torque of the motor is directly dependent on the amount of the rotor "slip," it can be seen that the slip must be different for various applications of the motor. The full load speed will necessarily be lowered as the "slip" is increased. It is generally easy to figure the full load speed if the slip is known. The slip in the standard motor is usually from 2 to 5 per cent, but where the starting conditions are severe, small motors may have a slip as high as 10 per cent. This probably would be an exceptional case, and the motor would have this high percentage of slip only when the starting torque was very high. Assume, as an example, that a motor has a slip of 5 per cent and a synchronous speed of 7200 revolutions per minute. The full load speed would then be 7200 revolutions per minute minus 5 per cent of 7200, or 6840 revolutions per minute.

Voltage Required at Different Speeds

In high-speed induction motors, the ratings are all based on a continuous duty with a temperature rise of 50 degrees C. The motors are designed to operate at either 120 cycles, both 110 and 220 volts, or 200 cycles, 110 volts. By referring to the right-hand columns B and C in chart No. 2, it will be noted that the voltage varies at the different frequencies given in column A. For example, a 110-volt motor operating at 120 cycles would require (as shown in column C) 165 volts at 180 cycles, and when operating at 60 cycles, it would require 55 volts. When the motor is designed for

Fig. 1. Chart giving Revolutions per Minute of Induction Motor at Different Frequencies

220 volts at 120 cycles, the number of volts given in column
C should be multiplied by 2. If the motors are to operate
over a wide range in frequency, it is desirable to have them
designed and wound to operate on 110 volts at 200 cycles.

By referring to columns B and C of the chart, it will be
noted that the motor designed to operate at 110 volts, 200
cycles, would operate at 168 volts, 300 cycles, while the
motor designed for 110 volts, 120 cycles, would operate at
275 volts, 300 cycles. If this motor had been designed for
220 volts, 120 cycles, it would operate at two times 275 volts
or 550 volts, 300 cycles. The limited space available on
these comparatively small motors makes it desirable to keep
the voltage as low as possible, since an increase in voltage
makes the problem of obtaining proper insulation more
difficult. The voltages that can be advantageously employed
are determined by local conditions in the operating plant,
and it is highly desirable in all cases to consult the motor
manufacturer with regard to the voltages to be used.

Probably the majority of motors used in the machine tool
industry are of the two-, four-, six-, or eight-pole type. The
synchronous speed of an alternating-current motor is ob-
tained by dividing the number of alternations per minute
by the number of poles. For example, let us consider a
two-pole motor operating on a 60-cycle circuit. Sixty cycles
is equivalent to 7200 alternations per minute, and dividing
this number by 2, the motor speed is found to be 3600 revo-
lutions per minute. Since a motor cannot have less than
two poles, 3600 revolutions per minute is the maximum
speed that can be obtained on a 60-cycle source of supply.
In order to obtain the higher speeds, it is necessary to in-
crease the frequency or the number of cycles per second.

Method of Obtaining High Frequency Current

There are several methods of obtaining high frequency
currents for operating high-speed motors. Probably the
simplest method is to utilize the induction frequency changer.
This consists essentially of a standard wound rotor type of
alternating-current motor, with certain modifications in the
design so that it will give the proper voltage at any pre-
determined frequency. It can be used only where alter-
nating current is available, irrespective of the frequency of
the incoming line. The fundamental theory of this gene-

rator is such that it has virtually the same characteristics
as an ordinary transformer.

If a standard alternating-current wound rotor type of
motor be used to pass a 60-cycle current in the stator and
the rotating element be held stationary, a current having
a frequency of 60 cycles would be induced in the rotor.
By making certain changes in the winding of the rotating
element, any desired voltage can be obtained. Under
normal conditions when the motor is operating at synchron-
ous or no load speed, there is practically no frequency gen-
erated in the rotor circuit, but if the rotor is revolved in
the opposite direction from that in which it would revolve
as a motor, there is generated in the rotating element a
current having a frequency above 60 cycles, and a certain
voltage which depends upon the speed at which the rotor is
driven.

Chart No. 2 shows at what speed the rotors of induction
motors having various windings must be revolved (in the
opposite direction from that in which they would normally
rotate when serving as motors) in order to obtain any given
frequency. As an example, assume that it is desirable to
obtain 120 cycles from a 60-cycle circuit. By referring to
column A and following the 120-cycle line to the right
until it intercepts the four-pole motor curve, and then fol-
lowing down the vertical line from the point of intersection
to the bottom of the chart, it is found that the rotor of this
motor would have to be driven at the rate of 1800 revolu-
tions per minute in a direction opposite to that in which
it would rotate if used as a motor. Therefore, by using a
four-pole motor directly connected to a four-pole, 60-cycle
squirrel cage motor, a complete motor-generator set for
obtaining 120 cycles is procured.

Again, assume that it is desirable to obtain 180 cycles.
It is understood that 1800 revolutions per minute is the
most desirable speed at which to drive a squirrel cage motor
operating from a 60-cycle source of supply. Following the
180-cycle line in column A until it intercepts the eight-
pole curve and then down the vertical line, it is found that
this machine can also be driven at 1800 revolutions per
minute. The same induction frequency generator could be
so wound as to give 180 cycles at either 99 or 165 volts,
depending upon the class of service that is desired. In
general, in order to obtain a higher num-
ber of cycles, the induction frequency gen-
erator will require a correspondingly high-
er number of poles, if it is desired to di-
rect-connect it to one of the standard
squirrel cage motors. Hence, it may be
noted from the curve that a 16-pole 60-
cycle generator would be required to obtain
300 cycles by using the standard 1800 revo-
lutions per minute 60-cycle motor.

Kilowatt Output

Chart No. 3 shows the relative capacities
of the motor and the induction high-fre-
quency generator (in terms of generator
output) for generating currents of different
frequencies. For example, assume that it is
desired to generate 100 kilowatts at 120
cycles. Following the 120-cycle line until
it intercepts the curve, and then follow-
ing the horizontal line to the left of the
intersection, it will be noted that the gen-
erator capacity will be 50 per cent that of
the total output, and the motor capacity
will also be 50 per cent of the total output.
Consequently, in this case both the genera-
tor and the motor will take 50 kilowatts
from the 60-cycle line. The sum of the
two always equals the total kilowatt output,
which in this case is 100 kilowatts.

Fig. 2. Chart giving Frequency, Voltage and Revolutions per Minute of Induction Generator
connected to 60-cycle Circuit

Again, assume that it is desired to have a 100-kilowatt output but at 200 cycles. Following the 200-cycle line until it intercepts the curve, and then following the horizontal line to the left, it will be noted that the generator will take 30 kilowatts from the line, and the motor will take 70 kilowatts. In this case, the generator supplies 30 kilowatts of the total 100 kilowatt output and the motor supplies the remaining 70 kilowatts.

For any given size of generator, the power input is the same, irrespective of the kilowatt output at the various frequencies. The kilowatt output from the generator is directly proportional to the increase in speed, and it is necessary for the motor to supply the additional power required to drive the generator at the increased speed. In other words, assuming that we have a motor-generator set of 10 kilowatt output at 120 cycles, the power input of this generator from the 60-cycle source of supply will be 50 per cent that of the output, or 5 kilowatts. The motor will supply the additional 5 kilowatts of the output as mechanical power at the generator shaft.

Suppose that it is desirable to obtain 180 cycles. This same generator will still take 5 kilowatts from the source of supply, but the kilowatt output will be correspondingly increased in direct proportion to the speed required to `:`n the 180 cycles, or, by referring to the curve, it will be found that the excitation of the generator at this point of the curve will be 33 1/3 per cent, the motor supplying 66 2/3 per cent. In this case, the excitation from the line is 5 kilowatts, or 33 1/3 per cent of the output. Therefore, the output of the machine is 15 kilowatts. It should be remembered, however, that these figures are theoretical, and it will be found in practice that the output will vary somewhat, depending on the efficiencies of the driving motor and the generator itself. All the induction frequency generators are designed for either 110 or 220 volts at 120 cycles, or 110 volts at 200 cycles.

Obtaining Desired Voltage

The voltage that will be generated at any given frequency may be found by reference to chart No. 2. If, by any chance, the operator happens to have only direct current available, it is necessary to use a direct-current motor-generator set, and in this case the generator would be of the alternating-current type. The motor-generator set would have the same characteristics as the induction frequency generator set; that is, the generator output would increase in proportion to the speed, but it would be necessary to increase the size of the motor to supply the additional mechanical energy required at the high speeds.

Obtaining Two Different Frequencies

In the event that it is desirable to obtain two different frequencies with the alternating current available, it is necessary to use a two-speed alternating-current motor. As an example, assume that 180 and 120 cycles are desired. From chart No. 2 it is noted that by using a standard 1800 revolutions per minute, 60-cycle motor, an eight-pole generator will be required to generate a current having a frequency of 180 cycles. The same curve shows that the eight-pole generator will have to be driven at 900 revolutions per minute in order to generate 120 cycles.

By referring to chart No. 1, it will be found that with a 60-cycle source of supply, a four-pole and an eight-pole motor would be necessary to obtain 1800 and 900 revolutions per minute, respectively. This pole combination can be taken care of on a single squirrel cage type of motor. Such motors can be designed for combinations of two and
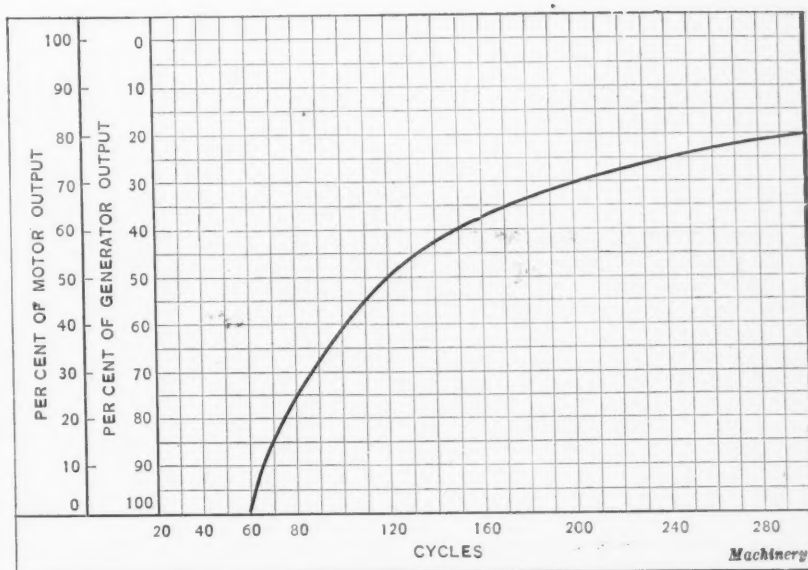
Fig. 3. Chart giving Percentage of Total Output of Motor and Generator of Induction Frequency Generator

four poles, four and eight poles, and six and twelve poles, to give the two different speeds required. It must be noted, however, that it is not commercially practical to obtain more than two particular speeds with an alternating-current motor. If greater frequency adjustment is desired, it is necessary to use a direct-current adjustable-speed motor as the driving unit for the generator set.

Automatic Control of Motors

High-frequency motors can be arranged to be controlled either by hand-operated switches or by full automatic or semi-automatic contactors—that is, contactors controlled and operated from push-button stations. In the application of high-speed motors, where there are several motors on a machine and it is desired to control them by means of push-buttons, a push-button station could be located at the operator's end of the machine and the contactors could be either housed on the machine itself or placed at some convenient point near the machine. The conduit carrying the wires from the contactors and push-buttons could be easily provided.

With a group drive on any machine, it is possible to arrange the automatic control in such a manner that the overload and no voltage relay would operate immediately to stop all motors, should any one of the motors stop. The feed motor and the tool motor are so interconnected through the control that in the event of the tool motor failing or becoming jammed, the overload relay would function so that the feed motor would also stop, and in this case would not continue to feed the material to the machine. The combination of an induction frequency generator and high-speed motors makes it possible to obtain the various combinations of speed required on different types of machine tools.

* * *

TESTS ON STEEL WIRE ROPE

Experiments made at the Bureau of Standards, as described in Technologic Paper No. 229, indicate that a six-strand, nineteen-wire, plow-steel, 5⁄8-inch wire rope, when bent over a 10-inch sheave, loses 12.6 per cent of the strength that it has when straight, and when bent over an 18-inch sheave, 4.7 per cent. A 1¼-inch rope loses 24.2 per cent, when bent over a 10-inch sheave, and 15.3 per cent on an 18-inch sheave. The wires of which the ropes were composed had a strength of 230,000 pounds per square inch, and the strength of the rope itself, when straight, equaled $83,000d^2$, in which d is the diameter of the rope in inches. The modulus of elasticity of steel wire rope may be assumed to be about 8,500,000.

Cutting Slots in Knitting Machine Parts

By FRED R. DANIELS
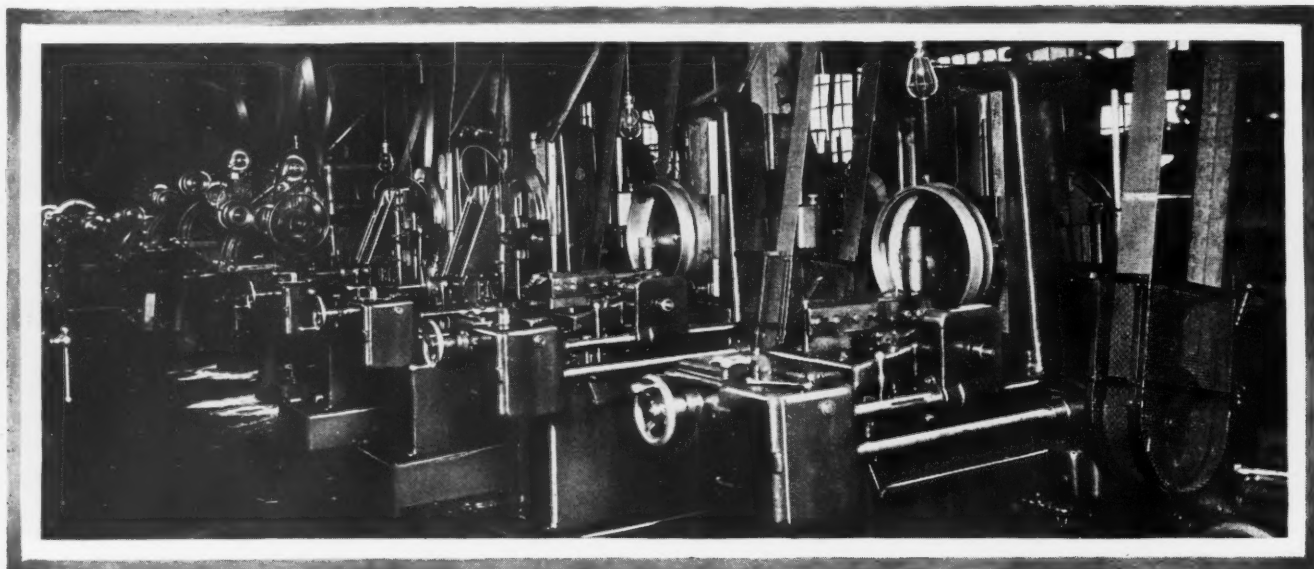
AN unusual adaptation of commercial gear-cutting machines is made in the plant of the Leighton Machine Co., Manchester, N. H., manufacturer of knitting machines. In this plant, a battery of Flather gear-cutting machines (see heading illustration) is used to mill radial slots in knitting machine needle plates, as well as internal axial slots in the cylinder that fits into the needle plate.

A top view of the knitting machine is shown in Fig. 1. The radial slots in plate A and the slots in the cylinder B, in order to align, as they must, have to be machined with an exceedingly high degree of accuracy. The chance for cumulative error between the slots on one side of either member and those on the opposite side is very great. The inner edge of the needle plate is beveled and fits the upper edge of the cylinder, and the knitting needles are arranged vertically in the cylinder slots and also in the needle plate slots. The cylinder turns first in one direction and then in the other, during the operation of the machine, and in each position all slots must align accurately.

An extensive change had to be made in the gear-cutting machines to adapt them for milling the radial slots in the needle plates, as is described in the following. The needle plates are forgings made from 0.30 per cent carbon steel. They must have no scarfs or seams in them, as this would weaken the plates considerably, on account of the closeness of the slots milled in them. The needle plates range from 10 to 48 inches in diameter, and the length of the radial slots may be as great as 6 inches. The width of the slots varies for different sizes of plates from 0.030 to 0.125 inch. The maximum depth of slot is ¼ inch, and the pitch or number of slots to the inch varies from 2½ to 14, measured on the inside of the central hole. The adjustments of the machine permit all sizes of plates to be slotted; in fact, much finer

pitches could be cut. Great accuracy of the dividing wheels is essential, owing to the necessity of perfect registry of these slots with those cut on the cylinders.

A view of the driving side of a machine for milling the needle plate grooves is shown in Fig. 2, and a close-up view of the work and special cutter-head arrangement from the opposite side of the machine is shown in Fig. 4. The regular cutter carriage of the Flather gear-cutting machine has been dispensed with and replaced by a special slide to which the bracket A, Fig. 4, is attached for carrying the cutter-head.

The work, instead of being mounted on an arbor with the cutter working from the under side across the face is mounted on a fixture fastened to the nose of the work-spindle, and the cutter-head travels vertically instead of horizontally. The vertical feed for the cutter-head is obtained from a vertical feed-screw driven by bevel gearing from a horizontal feed-shaft which occupies the position of the feed-screw in the regular machine. This shaft is driven from a clutch in the feed-box located at the front of the machine (see handwheel for feed-shaft, Fig. 2). During a cut, the cutter-head feeds down and is adequately counterweighted. Other changes in the machine have been made, but such features of the Flather machine as reversal of feed, and locking the feed while the index mechanism is in operation, are retained. Means are provided for setting the carriage along the ways of the machine in order to obtain the proper depth of cut. The changes affecting the feed may be understood by referring to Fig. 2. On the downward traverse of the work-head, the index mechanism is prevented from operating. The arrangement by which the locking mechanism is operated is the same as on the regular machine. As the cutter-head A approaches the extremity of its
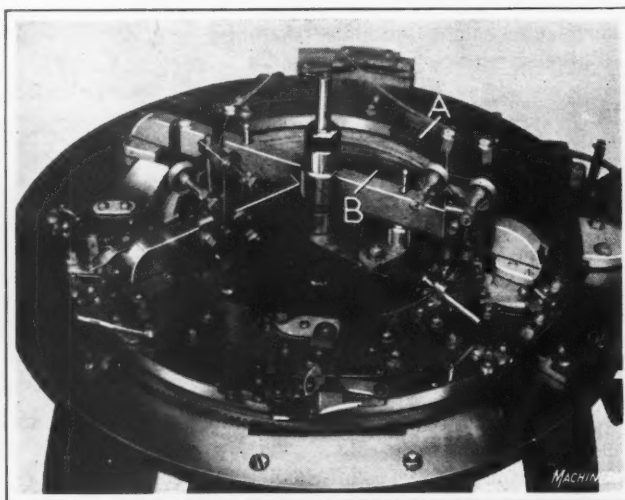
Fig. 1. View of Knitting Machine, indicating Slots in Needle Plate and Cylinder
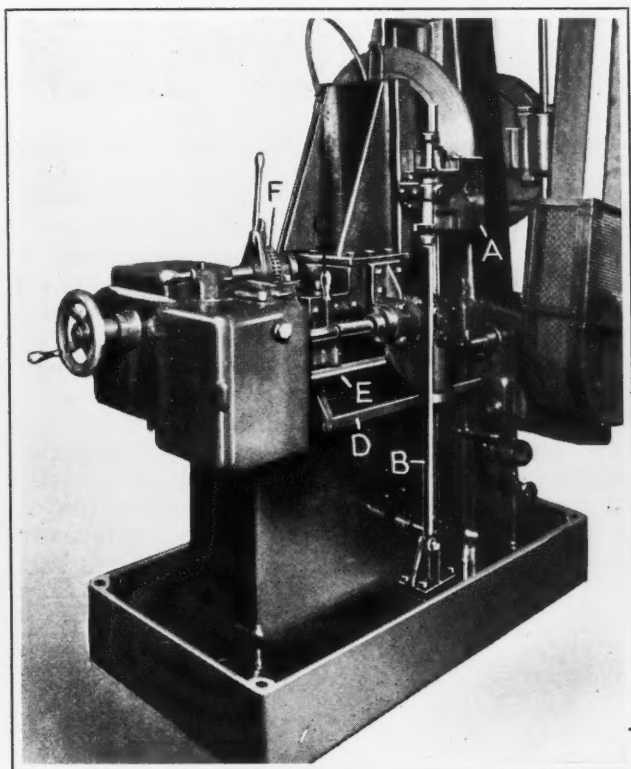
Fig. 2. Gear-cutting Machine adapted for cutting the Slots in Needle Plates
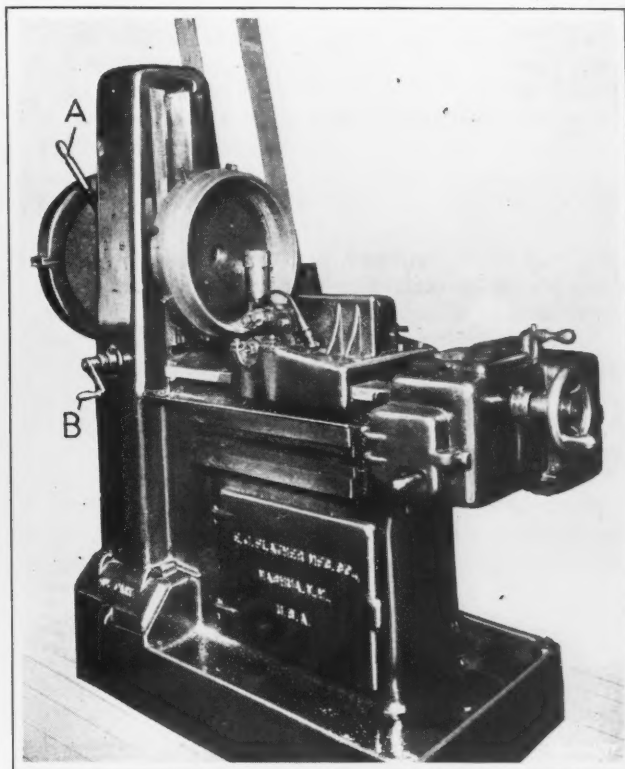
Fig. 3. Set-up of Gear-cutting Machine for milling Needle Slots in Cylinder Forgings

downward travel, it contacts with the lower of two stop-collars on rod B, which operates, through bell-crank levers, the feed-trip, the same as in the standard machine, throwing the clutch that reverses the feeding mechanism, and thereby returning the work-head to its upper position and lifting rod B preparatory to the performance of the next milling operation.

As soon as the cutter-head has been returned to the upper position, a locking cam in the feed-box is operated, throwing the lever C to the neutral position and actuating bar D, which operates the dividing mechanism contained in the housing in back of the driving pulley. The regular dividing mechanism is employed, which provides for releasing the feed-lever when the index movement has been completed. This permits the feed mechanism clutch to engage for the down feed.

The cutter-driving shaft is driven from the main driving shaft E of the machine, which is connected to a bevel gear shaft directly above it by change-gears in the gear-box. (The gear-box contains both the feed and speed change-gears, and the clutch-operating mechanism). This upper shaft drives a vertical shaft, through bevel gears, that is connected to the driving shaft of cutter-head A by a worm and worm-wheel of 6 to 1 ratio.

The setting of the work-head slide is regulated by a ratchet wheel F (see also Fig. 4) and a spring pin which engages the teeth as

Fig. 4. Special Slide carrying Cutter-head of Machine shown in Fig. 2

the handle is turned. A graduated collar B (Fig. 4) permits the setting to be accurately made. The cutters, or saws, are $2\frac{5}{8}$ inches in diameter, each being mounted on a small arbor which also carries a spur gear by means of which the arbor is revolved by the gear train from the cutter-driving shaft. The cutter is ground on its arbor, which keeps it concentric. When a nominal cutter speed of 250 to 300 revolutions per minute is employed, and the cutters are reground after 300 to 350 cuts, 4 to 6 inches long, have been taken, the cutter breakage is practically eliminated. One operator can take care of several machines.

The needle plates are turned in a lathe while mounted on the same fixture that carries them during the milling operation, thus assuring concentricity. In fact, the plate remains on the fixture in most cases until after subsequent operations are performed. The fixture itself is simply a circular plate mounted on the nose of the work-spindle, and the needle plate is screwed to this fixture. The binder plate clamps the work-spindle head to the column by means of handle A, Fig. 3, the same as in the standard machines.

The change for the cylinder-slotting operation is not as radical as in the case of the needle plate machine. Referring to Fig. 3, it will be seen that the regular cutter-slide is used, with a special bracket attached to it on which the cutter is carried, the latter being

driven by a chain of spur gears from the regular cutter-arbor. The arbor carries the gear for driving the gear train. There is considerable overhang of the cutter on this account, so that in order to counteract vibration, the bracket that carries the gear train is suitably weighted directly above the cutter. The depth of cut in this case is obtained in the regular manner, that is, by moving the work up or down on the column by means of crank-handle B.

The edge of the cylinders, and sometimes the inner edge of the plates, is chamfered to remove the sharp corners where the slots break out. This operation is done without changing the position of the work, by using the regular slotting cutters. This is made possible by the design of the dividing mechanism, which can be disengaged to permit the work to index continuously. The bevel is produced after the fashion of a gear-hobbing operation, the cutter and work revolving in unison. This is a means, of course, for obtaining concentricity between the outer edge and the slots. The mounting of the work-holding fixture is the

VISE ATTACHMENT THAT FACILITATES FILING OPERATIONS

The vise attachment here illustrated has been found to facilitate greatly the filing operations required in making pieces such as the one shown by the heavy dot-and-dash lines at A. This piece is made from sheet metal, 0.050 inch thick, and is bent to the shape indicated by the end view, on a hand-folding machine. Considerable care is required in filing the V-notch shown at X, as it must be accurate with respect to its size, shape, and position. Notches C cut in the jaws J and K serve to guide the file so that the desired accuracy will be obtained. A scale D with an adjustable stop B is provided, which permits the distance from the center of the slot to the left-hand end of the piece to be gaged for pieces of different lengths.

The scale is graduated to 1/32 inch, although only the inch divisions are shown in the illustration. It will be noted that the zero mark on the scale is in line with the center of the V-notch in the vise-jaw blocks J and K. The end of the
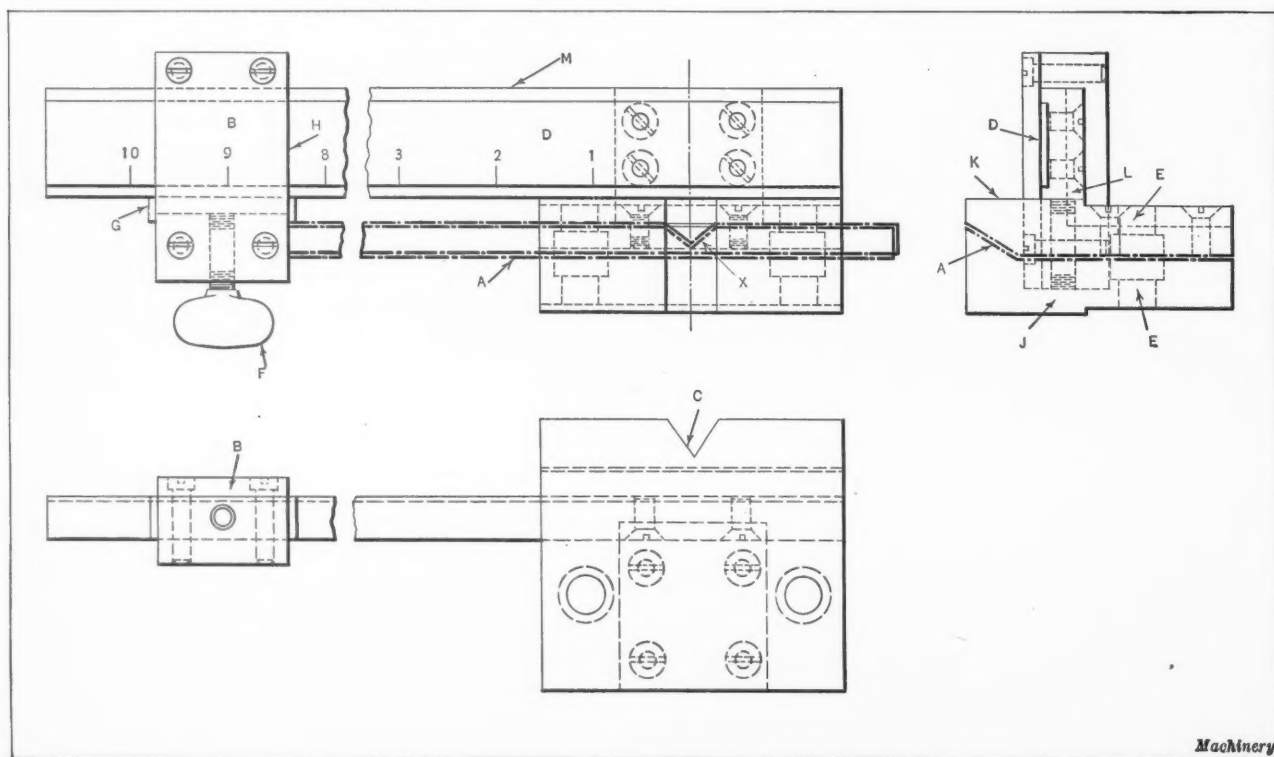
Vise Attachment used in filing V-shaped Notches in Sheet-metal Parts

same for both classes of work, but suitable changes are made to accommodate different designs of forgings.

It is stated by the Leighton Machine Co. that the degree of accuracy necessary is realized and that a gain of 50 per cent in production is obtained by this unusual application of gear-cutting machines.

* * *

THE EFFECT OF VALVES ON HEAD OF WATER

Experiments have been conducted at the University of Wisconsin to determine the loss of head due to the flow of water through valves. In the test made, forty-eight valves were tested, ranging in size from ½ up to 12 inches, and including both gate valves and ordinary globe valves. Full information is obtainable in the Engineering Series, Vol. IX, No. 1, of the Bulletin of the University of Wisconsin. The globe valves, it was found, offered from fifteen to forty times the resistance of gate valves of the same size, the ratio being higher the larger the valves. The length of pipe that would cause the same loss of head as a valve ranged from ½ to 4 feet in the case of fully opened gate valves, and from 20 to 35 feet for fully opened globe valves.

piece to be notched is located by the edge H of stop B. It is evident, therefore, that it is only necessary to adjust stop B so that edge H is on the proper graduation to obtain the desired spacing of the V-slot from the left-hand end of the piece. The gage-block B can be locked in place when it is set in the required position, by means of the wing-nut F, which presses against a key G bearing against the edge of bar M.

The jaws J and K are attached to the bench vise in the usual manner, by means of screws that fit the counterbored holes E. An angle-iron L is attached to jaw K, and bar M is mounted on part L. As the piece to be notched is very thin, only a few rapid passes of the file across the work are necessary to produce the required notch in the work. The jaws J and K are, of course, hardened so that they will retain their shape and resist the marring or wearing action of the file in the V-notch.

The idea of performing minor operations in vise jaws such as the one described in the foregoing has a wide application, particularly when parts that vary somewhat from the standard products are required in but limited quantities.　　　　　　　　　　　　　　　　　　　　　　H. M.

Running-in Tests for Machine Tool Units

By DOUGLAS T. HAMILTON, Fellows Gear Shaper Co., Springfield, Vt.

IT is customary in the manufacture of machine tools—especially those that are to be used for the production of very accurate work—to give the complete machine a thorough running test before it is shipped. This practice is adhered to by the Fellows Gear Shaper Co., Springfield, Vt., in the manufacture of its gear shapers. In the case of the high-speed gear shaper recently developed by this company, some of the more important unit assemblies are subjected to a separate running-in test before they are assembled in the complete machine.

This gear shaper is essentially a high-production machine and is designed to operate at high speeds. For this reason, it is necessary that the bearings and operating members be

A and a pulley B from an overhead countershaft. The rotary speed imparted to the worm, worm-wheel, and cutter-spindle is many times greater than the highest working speed. The cutter-spindle and guides are reciprocated at the same time at a high speed by means of shaft C, Fig. 2, which operates the connecting-rod D, Fig. 1. The pulley on shaft C is also driven from the overhead countershaft. The upper index-wheel gib, which is made from a cast-iron ring carefully ground, is brought to bear on the top face of the upper worm-wheel with the necessary pressure to hold the latter firmly down on its seat in the saddle. This seat and the lower surface of the worm-wheel are scraped to an accurate surface and tested before running in.
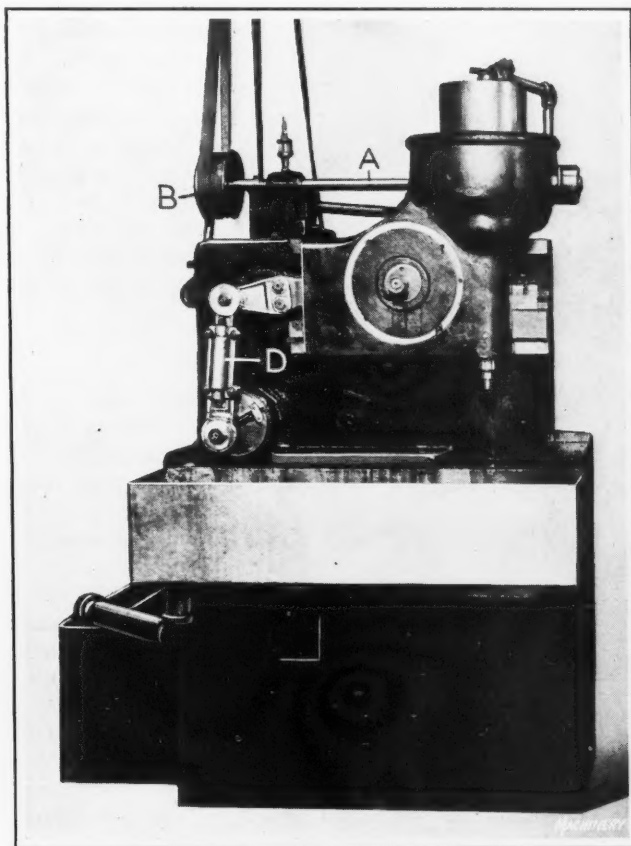
Fig. 1. Running-in Device for Cutter-spindle Assembly of Gear Shaper

Fig. 2. Rear View of the Running-in Device illustrated in Fig. 1

fitted and adjusted with extreme care in order to eliminate any possibility of excessive heating or seizing when the machine is in operation. In the unit assembly test, as well as the final assembly test of the complete machine, the shafts and sliding members are operated at much higher speeds and under more severe conditions than they would be subjected to in the actual operation of cutting gears. The accompanying illustrations and descriptions of the devices developed for the running-in tests of two units of the high-speed shaper may be of interest to those who find it necessary or desirable to adopt similar means of testing unit assemblies that go to make up a complete machine.

Running in the Cutter-spindle Assembly

The saddle assembly unit that contains the cutter-spindle is shown in Figs. 1 and 2 arranged on a temporary bed for the running-in test. The upper worm is driven by a shaft

It obviously would be impossible to operate these members at high speed for any length of time without liberally flooding the bearing surfaces with oil. Therefore provision is made, as shown in Fig. 2, for pumping a constant supply of oil to the working members. It will be noticed that the oil-pipe is carried to the upper worm-wheel housing. This assures the thorough lubrication of the guides, cutter-spindle, cutter-spindle bushing, worm, worm-wheel, gear, etc. Provision is also made for returning the oil to the tank after it has served its purpose.

It should be mentioned here that the cutter-spindle used on this machine is made in one piece and that the lower end must be an exceptionally good fit in the bushing. Both the cutter-spindle and the bearing have ground surfaces, and the maximum clearance permitted between these members is 0.00025 inch. It is evident that a slight change in temperature will cause this bearing and spindle to seize

unless the contacting surfaces are accurately finished and have smooth bearing surfaces. It is also necessary to furnish the surfaces with a good supply of light machine oil. These members are run in under a copious supply of lubricant for five hours. They are periodically inspected to see that there is no excessive rise in temperature.

Running in the Work-spindle Assembly

The work-spindle A and quill B, Fig. 3, are given a still more rigid test. The apron and relieving lever assembly C is placed in the base F, which is a duplicate of the regular base used on the machine. Two of these bases are clamped together, as shown, so that two units can be run in at the same time. The work-spindle A has three bearing points in the quill B at the top where the two flat surfaces come together. Then there is a taper fit, and finally a straight bearing fit at the lower or inner end of the work-spindle. The taper and straight bearing surfaces in the quill and work-spindle are both ground to a fit, and then the top surface on the quill is scraped to a surface fit with the work-spindle.

After these members have been carefully fitted, inspected, and assembled, the completed unit is placed in the base, as shown. Now there are three important points that must be taken care of; one is the fit of the quill in the four-point bearing in the base; another is the expanding action of the reverse taper work-arbor when it is drawn up rigidly into the work-spindle (which is the case when a gear is being held in place); and a third condition to be considered is the downward pull on the work-spindle, which holds it on its seat in the quill.

It has been found by experiment that the quill is held on the four-point seat in the base by a pressure of 275 pounds; hence, the lever D, shown in Fig. 3, with the weight E attached, holds the quill on the seat under exactly the same conditions as when the part is in actual operation. The second point is taken care of by inserting a work-arbor G into the work-spindle A and clamping it in place. For holding the work-spindle down on its seat, a spring pad is arranged at the lower end which pulls the work-spindle down with a force of approximately 250 pounds.

The work-spindle is driven by a pin-type coupling H, so that none of the driving thrusts are transmitted to the spindle to throw it out of line, the drive being taken care of by a one-half horsepower motor J. The work-spindle is rotated at a speed of 100 revolutions per minute, which is more than twenty-five times faster than it would operate in cutting a gear. Oil is supplied to the three bearing surfaces of the spindle under a pressure of 30 pounds per square inch.

The members thus assembled are given a running-in test for six hours, then dismantled from the stand, disassembled and carefully inspected, and again put together and inspected for accuracy before being approved.

Running in the Completed Machine

After the two units previously referred to have been given a careful running-in test, the remaining units of the machine are assembled, and a final running-in test is given. In this particular case, all the working members of the machine are run in with the machine belted up in the same manner as in actual operation. The pump ordinarily used for supplying coolant to the cutter and work is, in this case, used to supply light machine oil to all the bearings. The regular lubricating pump used for supplying oil to the various bearings and gears in the bed when the machine is in actual operation is also utilized at this time. Under this test, the machine is operated at a higher speed than that usually recommended, and it is kept at this speed for five hours. It is inspected periodically, and any excessive increase in bearing temperature that might develop is noted.

The object of this test is to insure that no trouble will be experienced when the machine is put on production work. The machine is in all cases operated under actual cutting conditions, with the exception that no actual cutting is done. This is done later, and is the final test given the machine before it is shipped. In this test, a gear of the coarsest pitch for which the machine is recommended is cut. This gear is carefully tested on a recording instrument, and must pass a rigid inspection before the machine is approved.

* * *

Mexico will soon become one of the United States' best customers for industrial machinery, according to C. V. Allen, manager for Mexico of the Westinghouse Electric International Co., who recently was in the United States on a brief business trip. "Mexico," said Mr. Allen, "is now in a better condition than it has ever been since the revolution." The railroads are in good condition, and the telegraph and postal services are now dependable. The number of industrial undertakings has increased considerably, and the main need of Mexico at this time is foreign capital; but capital can be attracted only after an agreement has been reached about property rights of foreigners and other matters of importance to foreign investors.

Fig. 3. Running-in Device for Gear Shaper Work-spindle

* * *

RUSTLESS IRON

According to the London *Iron Monger*, rustless iron is now being produced in Sweden by a process that is stated to bring the cost of the finished product down to approximately that of ordinary commercial mild steel, when account is taken of the exceptional strength and durability of the new material, whereby lighter cross-sections can be used for the same service. A saving is also met with in the fact that there is no need of using rust-resisting coatings. The process is electrical, and the iron is claimed to be impervious to rust and corrosion.
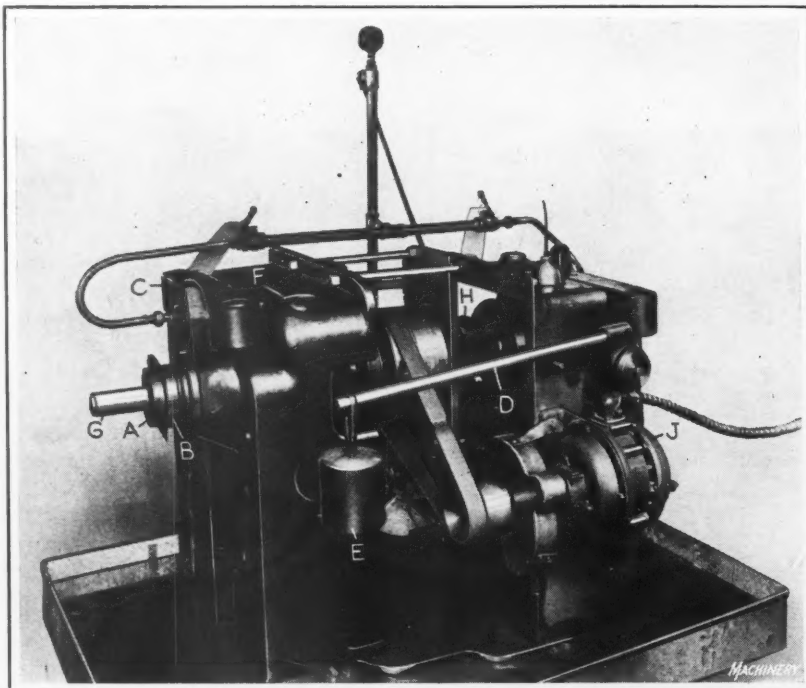
LAYING OUT MASTER CAM TEMPLETS

By EDWARD J. RANTSCH
Master Mechanic, Metal Package Corporation, Brooklyn, N.Y.

The subject of laying out master cam templets and making master cams, while an old one, is not generally understood, and it is therefore believed that the following article will be of interest. The usual method of laying out cams by hand will first be described, after which an improved method will be dealt with. In Fig. 1 the outline of part of a face
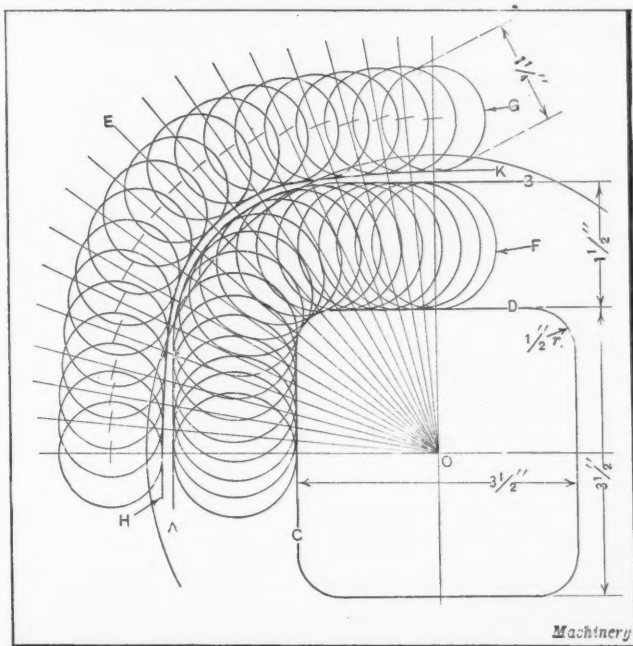

Fig. 1. Method of laying out Master Cam Profile by Hand

cam is indicated by lines *AB* and *CD*. These lines represent the contact surfaces of the groove which is to be cut in the face of the cam. The center of the square portion is $3\frac{1}{2}$ inches across the flats, and the corners are rounded to a radius of $\frac{1}{2}$ inch. The groove for the roller is $1\frac{1}{2}$ inches wide.

In making the master templet, the first step is to lay off the square, $3\frac{1}{2}$ inches across flats, with its corners rounded to a radius of $\frac{1}{2}$ inch. The lay-out is made on a thin piece of sheet steel or gold lacquered tin. Extreme care must be taken to have sharp points on the scribers and the dividers. A large circle is next drawn about the center *O*. This circle is divided into 360 parts, and radial lines *OE* are drawn through the division points. Circles $1\frac{1}{2}$ inches in diameter, as shown at *F*, with their centers located on the radial lines, are drawn tangent to the sides and rounded corners of the square. These circles indicate the positions successively occupied by the roller in the cam groove.

The path followed by the roller on the master forming cam is next developed on the drawing. This roller, represented by circle *G*, rotates about a stud in the bracket of the cam-cutting attachment of the milling machine, and is securely bolted to the stationary part of the attachment. The centers of the second series of circles are located at a distance of, say, 2 inches from the centers of the first series of circles. The diameter of the second series of circles must be equal to the diameter of the roll on the cam-cutting attachment. In this instance, the diameter of the roller is assumed to be $1\frac{1}{4}$ inches. The line *HK* which is drawn tangent to these circles establishes the shape or profile of the master templet, which is to be cut out and carefully filed to the profile line. After the templet is made, it is necessary to transfer the profile to the

master former or master cam which, in this instance, is to be made of cast iron $\frac{1}{2}$ inch thick.

The master cam is then finished to the line that has thus been transferred. Even if the master templet and master cam or former have been very carefully made, it is usually necessary to do a certain amount of smoothing up in trying out the cam on the cam-cutting attachment. The diameter of the end-mill required to cut the groove in the cam face must, of course, be $1\frac{1}{2}$ inches, as a cutter of any other size would not give the desired profile. Had the roller groove been 1 inch wide instead of $1\frac{1}{2}$ inches, the circles *F* would have been made 1 inch in diameter. In this case it would have been necessary to use an end-mill 1 inch in diameter.

Improved Method of Laying out Master Templets

A device designed especially for laying out master cams is shown in Fig. 2. Its purpose is to eliminate errors, save time, and produce a better quality of work than is possible by the hand method. The device is simple, and very little instruction or practice is required to enable an inexperienced worker to make accurate lay-outs for master templets.

The first step in making a master templet lay-out is to provide a steel templet about 1/16 inch thick, the exact size and shape of the inner part or surface of the cam to be made. In the case of the square cam outlined in Fig. 1, a steel templet $3\frac{1}{2}$ inches square across flats, with corners rounded to a radius of $\frac{1}{2}$ inch, would be required. Having finished the templet to this size, a $\frac{7}{8}$-inch diameter hole is located and drilled in the center. This permits the templet to be placed in a central position on the table of the lay-out device shown in Fig. 2. Underneath this steel templet is placed the blank upon which the lay-out of the master templet is to be made. The two pieces are secured to the table of the device by means of two small screws, holes being drilled through the steel templet and the blank for this purpose.

The arm *A*, which can be revolved about pin *B*, carries the slide *C* on which is a round disk *D*, the diameter of which is equal to the diameter of the roller that is to operate in the cam groove. In this case, the roller has a diameter of $1\frac{1}{2}$ inches. The disk bears against the edge of the steel templet and is kept in contact with it by means of a spring *E*. In laying out a master templet, the arm *A* is moved one degree and the handle *F* of the circle-scribing attachment is given one revolution. This causes a small arc
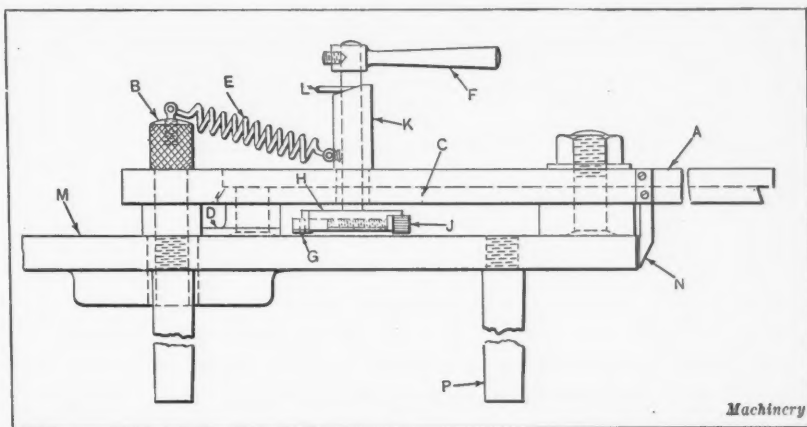
Fig. 2. Device for laying out Cam Profiles

to be scribed on the work, the radius of which is equal to the radius of the roller on the cam-cutting attachment. By moving the arm one degree at a time and scribing an arc at each setting or movement of the arm *A*, the shape or profile of the master cam templet is produced directly. An irregular shaped cam templet produced in this manner is shown in Fig. 3.

This method of producing templets eliminates much of the work outlined in the preceding description of the hand

lay-out method. Radial lines, full circles, etc., are not necessary in the improved method. After the lay-out has been made on the gold lacquered tin or sheet-metal templet, the latter is removed and the arm A, Fig. 2, is taken from the device. The table of the lay-out device is then used to support the work while it is being-filed to the profile line. A magnifying glass is held over the work by means of an adjustable bracket during the filing operation. The templet is cut very close to the line before filing. A phonograph needle G is used as a scribing point to produce the series of arcs that develop the profile of the templet. The needle is held in a slide H, which permits it to be adjusted by means of screw J so that arcs of any desired radius within the capacity of the device can be scribed. The upper end of part K is beveled so that it acts as a cam to raise the scribing point from the surface of the work when lever F is revolved far enough to cause pin L to come in contact with the highest point on part K.

The circular table M is graduated around its entire edge into 360 degrees. No graduations are shown in the illustration, although the pointer used in connection with the
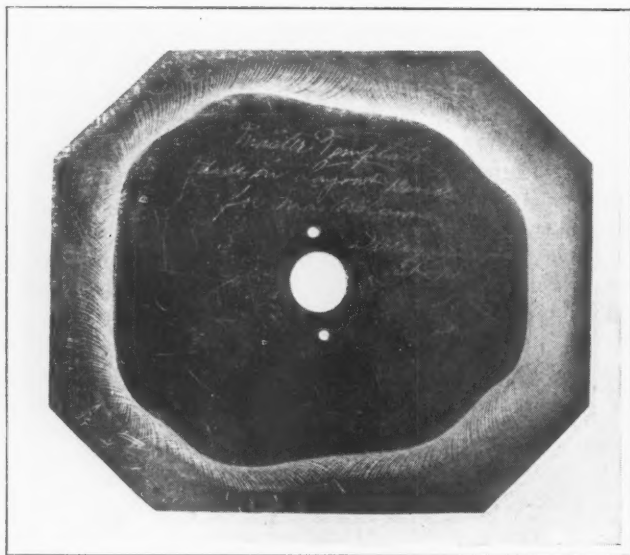
Fig. 3. Master Cam Templet laid out with Device shown in Fig. 2

graduations is shown at N. The device is shown without the steel templet in place, the disk D being shown in contact with the arbor or stud on which the steel templet would be placed. The back of disk D is cut away to permit the scribing point G to be adjusted as close to the center of the disk as conditions may require. Round steel legs P are employed to support the table. Referring to Fig. 3, which shows one of the templets laid out with the device shown in Fig. 2, it will be noted that the scribed arcs give a clearly defined outline for the templet profile. It is an easy matter to finish the templet to the profile thus formed by means of a hand file.

* * *

STEEL INDUSTRY IN BRAZIL

Quite rapid developments are taking place in the iron and steel industry in Brazil. An effort is being made by the Brazilian Government to provide for the nation's iron and steel demands by utilizing as far as possible the resources that exist within the country. Brazil possesses large deposits of high-grade iron ore, and it would be possible not only to supply all the iron and steel required for the domestic needs of Brazil, but also to produce a sufficient quantity for export to other South American countries. A drawback to the exploitation of iron ore deposits in Brazil is found in the lack of fuel, which makes it necessary either to bring the iron ore from the mines to the coast—a distance of over 300 miles—or to bring the coal from the coast to the mining region.

THE BROADER VIEW OF BUSINESS

We have reached a stage of national development of such complexity and interdependence of economic life that we must have a national planning of industry and commerce. We have gained a larger prospective than individual business, because individual prosperity is impossible without the prosperity of the whole. This is the function of industry and commerce itself through collective thought. Government has a definite relationship to it, not as an agency for production and distribution of commodities, nor as an economic dictator, but as the greatest contributor in the determination of fact and of cooperation with industry and commerce in the solution of its problems.

We have in America an economic and social system based on stimulation of individual initiative. Our ideal is to secure and to maintain an equality of opportunity to all. We have honestly sought over years to find methods by which we could curb those who would dominate the community and thus stifle the initiative and opportunity of the greater numbers. Nor must we relax vigilance in this particular. But we have also in these times to fight that this initiative shall not be destroyed by those who would divert actual production and distribution into the hands of the Government. The exact line to be drawn in the curbing of people whose ambition is to interfere with the law of supply and demand to their profit, without return of service to the community, on the one hand, and the extinction of initiative by the heavy hand of Government on the other, is at all times difficult to determine.

Our goal in economic life is to do this great thing, to preserve individual initiative, an equality of opportunity, and thus a constantly advancing national standard of living. Our economic and social system is fundamentally right. It has produced the largest advance in the standard of living to the whole of our people that has ever been witnessed in history. Its faults are many, but they can be and are being corrected without destroying its progress. It has brought us steady advances despite the fabulous losses of war, and must therefore have great inherent vitality. In short, this great conception of America that every man should be given an equality of opportunity to take that position in the community to which he is entitled by virtue of his character and ability, is the keystone of our structure. We must preserve it as the most precious thing we possess, for the finer flowers of civilization do not grow from the cellars of poverty any more than from the palace of extravagance. They grow from the bettering comfort and well-being of the whole of great peoples.—*Herbert Hoover*

* * *

TRADE ASSOCIATION ACTIVITIES

A book on trade associations has been published by the Department of Commerce, and can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 50 cents a copy. The book is entitled "Trade Association Activities," and deals extensively in its 368 pages with the varied work that may advantageously be undertaken by trade associations. Secretary Hoover has written an introduction to the volume in which he expresses the opinion that the constructive purposes of trade associations have unfortunately been confused with the minority of activities which have been used by a few organizations as a cloak for action against the public interest. Secretary Hoover believes that trade associations have a very important and useful service to perform, and that the true interest of any one industry or trade, to be sound in the ultimate analysis, must be the public interest. There are many useful activities that can only be accomplished by collective action in a trade. The elimination of waste through standardization is one of these. Such activities bring about lower prices by reducing the costs of raw materials, inefficiency in plant operation, and the maintenance of large stocks.
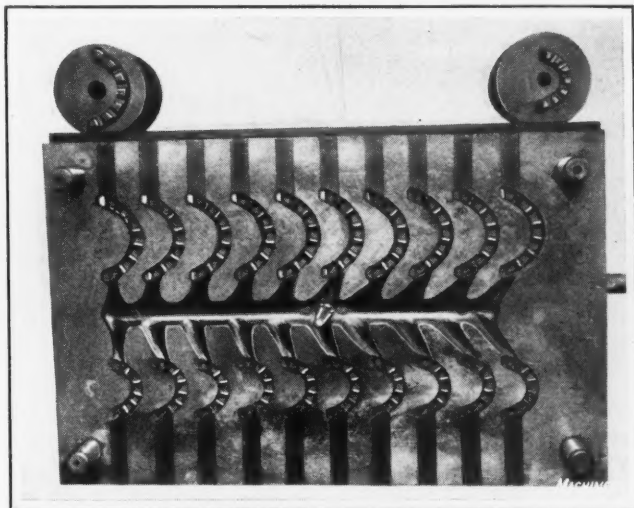
Solving Die-casting Problems

Fig. 1. Multiple-impression Die, showing Hobs used in sinking Impressions

Fig. 2. Ejector Die embodying an Ingenious Interlocking Slide Construction

THE problems commonly encountered in the economical production of die-castings lie in constructing the die so as to produce the casting with the least difficulty, and in obtaining accuracy in sinking the die impression. This article contains information bearing on these problems, obtained at the plant of the Atlas Die Casting Corporation, Worcester, Mass.

Producing a Multiple-impression Die

The die shown in Fig. 1 is of interest because of the unusual method employed in producing the multiple impressions. This die is made from chrome-vanadium steel, and is used in die-casting aluminum alloy rubber-heel plates. The twenty impressions in this ejector member of the die were produced by hydraulic pressure, using hobs and a hydraulic press. The hobs used are of the type shown resting on top of the die. A fifty-ton press is employed for the smaller sizes in plates, and a three hundred-ton press for the larger impressions. It will be apparent from an inspection of the ribs or raised portions in each impression that it would entail a prohibitive cost to machine each separately.

A die of unusual construction, which displays considerable ingenuity in its design, is used to produce the slide shown enlarged in Fig. 3. The slide is used in the construction of the Lux clock—a savings bank slot machine in which a nickel must be deposited before it can be wound. A view of the ejector die member, showing the slide arrangement used in casting the slots in this part, is shown in Fig. 2; Fig. 4 is a diagrammatic view, showing how the slides are arranged to produce the slots.

Reference to Fig. 3 will reveal some of the difficulties that this casting presents to the designer of die-casting dies. There is a square hole that must be cast by a movable core, drawn perpendicular to the side slots, so that evidently the work must lie flat in the die to permit the square core to be drawn vertically. Then there are the two slots
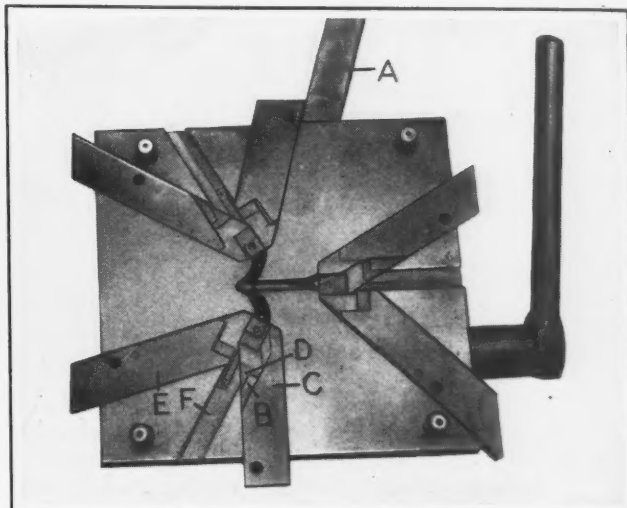
Fig. 3. Enlarged View of Die-casting produced in Die shown in Fig. 2

A and B, above and below the long flat projecting finger C. The slots have a peculiar shape at the bottom which prevents casting them by cores or slides drawn from the side in the same direction that the slides for the two side slots would naturally be drawn.

Furthermore, there is the overhanging unsupported finger C with a hole at the end. The die parts must be devised so that the casting can be readily freed without using too complicated a slide arrangement. Of course a slide arrangement is necessary or, at least, such an arrangement is the most obvious solution of the problem, as the end slots offer no ready means, other than slides, for supporting finger C in the die. The top surface of one of these slots forms the under surface of the finger, and the lower surface of the other slot forms the top surface of the finger. Loose pieces set into the die to cast either of these slots would probably not be practicable, because the finger is not the same width as the body in which the slots are cast. A study of the design will show this to be true.

The die for casting this unusual part consists of three pairs of slides operated by handle A, Fig. 2, which revolves a cam-plate to move the slides radially. One member of each of this pair of slides forms the core for slot A, Fig. 3, and one of the side slots, while the other slide member produces the core for slot B and the other side slot. At each station of the die there is a groove in which the impression for part of finger C is sunk and through which the core for the round hole operates.

The two slides, after they have been closed to make the casting, are so formed that they interlock, and a lip B (Figs. 2 and 4) forms the remainder of the vertical side of the finger impression, which was cut into in fitting the slide C into the die. When slide C has advanced to this position, the lip D extends in under the projecting finger to provide a core for slot A, Fig. 3. The other slide E, Fig. 2, has a similar lip for coring slot B, Fig. 3, and when both
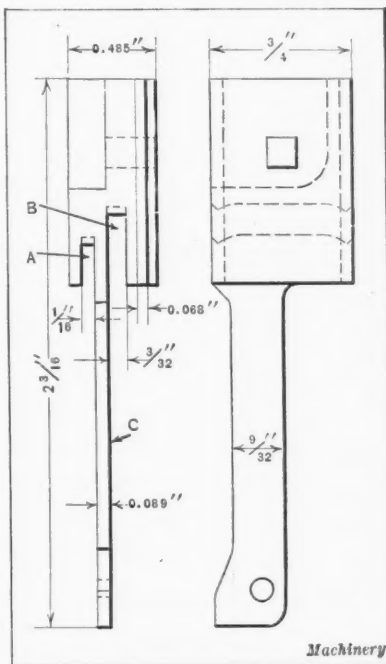
slides are closed, the portion of the finger impression that is adjacent to the main part of the casting is entirely formed. The under side of slide E forms the top wall of this part of the impression, and the lower wall is sunk in the die; the sides are partly sunk and partly formed by slide C. When the two slides have been advanced and the dies are closed, a block on the cover die fits into the rectangular groove F, closing it and forming the remainder of the top surface of this shallow finger cavity.

The diagram Fig. 4 shows, in full lines, the position of the slides when closed, and of the block F on the cover die for closing the impression. The diagram also indicates by dot-and-dash outline the location of the work, and by heavy dot-and-dash outline the position of the slides before closing. In the plan views, the relative positions of the lips on the slides and a section G of the projecting finger are indicated. Other features incorporated in this die are the familiar ones of multiple gating, dowel-pins on the cover die for locking the slides, water-cooling, etc.

Die for Typewriter Frame

The dies used in casting an Underwood typewriter frame are also of interesting design, as will be seen by reference to Fig. 5. The principal point of interest is the locating of the several inserts that are cast into the walls. The casting itself, showing some of these brass inserts, may be seen resting on top of the cover die. The inside of the casting is ribbed, and the main rectangular-shaped core of the ejector die produces these ribbed walls. The end walls of the frame are cut away, and each contains five brass inserts. The core arrangement for this portion of the die is of interest.

There are two loose cores used in the ends, one of which has been removed from its position in the die, as shown at A, while its mate B is shown in place. These cores are fitted to the die proper by a tongue and groove and by dowel-pins. The brass inserts are placed in the cores before the latter are put in the die, and these loose core pieces are ejected with the casting and subsequently removed from it. The two ejector-pins for removing the loose
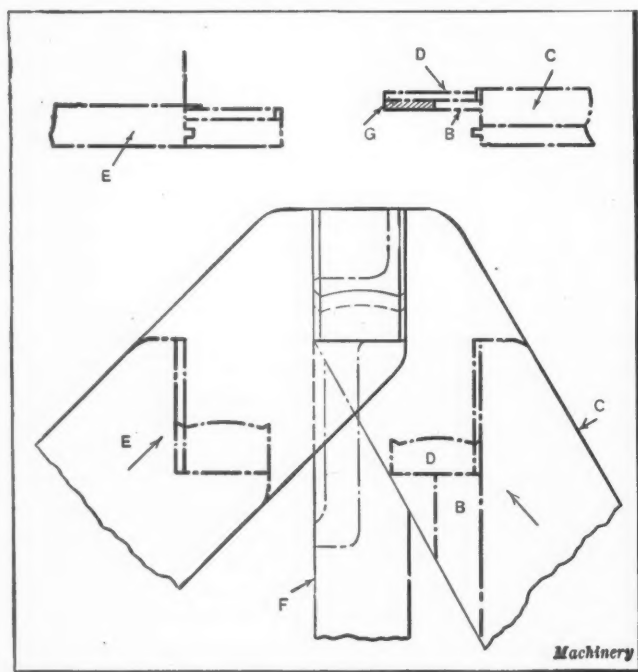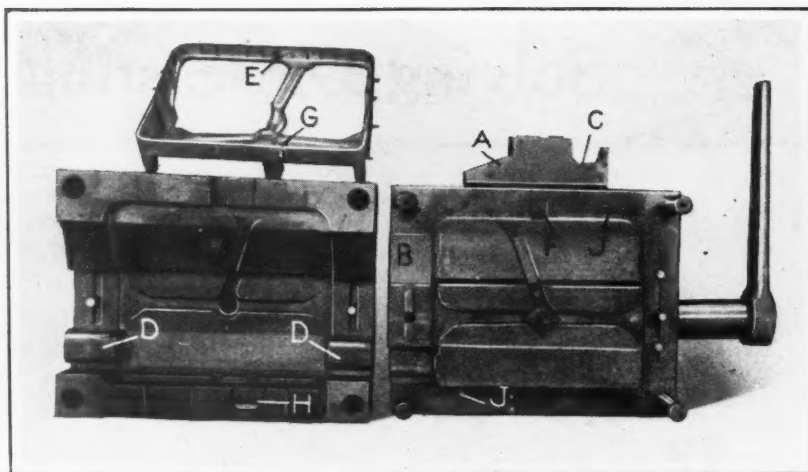
Fig. 5.   Typewriter Frame Die-casting and Dies in which it is cast

core with the casting are shown in the slot at the right-hand side of the ejector die; the dowel-pins by which it is held in place may also be seen.

The top of each of these two loose cores has a tongue which fits into the cover die, as well as a cut-out section C between which and the corresponding projections D on the cover die, a cut-out is cast in the side walls of the typewriter frame. There is a lug E on the inside of one side wall and a similar one G on the inside of the other; these are also produced by auxiliary cores. The square core F has a hole in it for locating the brass insert for lug E. This core or post is attached to the ejector-plate, and is raised with it so that the insert can be slipped into place. It is necessary to pull the casting sidewise from this post after it has been ejected by the regular rack-operated ejector-plate. Another loose piece is used on the opposite side to form the lug G and provide means for holding the brass insert in it. This loose core fits over the two dowel-pins at the lower part of the ejector die, but for convenience the core itself is shown on the cover die at H.

The arrangement of the ejector-pins is also interesting, because there are so many required to remove the casting and the cores. They are located all around the main rectangular stationary core, and are so positioned that one-half of each pin bears on the end wall of the casting; the other half of the pins under cores A and B bear on these movable cores. In this way they aid in ejecting the heavy loose cores.

In addition to these ejector-pins and the two in each groove for the loose cores, there are four similar pins J, one at each corner, which operate from the ejector-plate but which are not ejector-pins. They are known as surface pins, and they are used to indicate when the ejector-pins have been completely withdrawn before closing the die. This is very important, because a projecting ejector-pin will cast an impression in the surface of the casting, and an ejector-pin that is depressed too much will cast a boss on the surface.

* * *

The Michigan Central Railroad has conducted experiments for several months with Stafford roller bearings applied to a six-wheel truck running under an American Railway Express car, and also applied to an 80,000-pound capacity box car and other freight cars of the same capacity. These cars have traveled a total of 8375 miles after the bearings were applied, with practically no repairs of any of the bearings. While no dynamometer tests have yet been made on cars equipped with this bearing, it is stated that there is a great reduction in frictional resistance, as indicated by the fact that one of the cars was loaded until the gross weight amounted to 122,600 pounds, and one man was able to push this car along a level track.

Fig. 4.   Views showing Closed and Open Positions of Slides

Letters on Practical Subjects
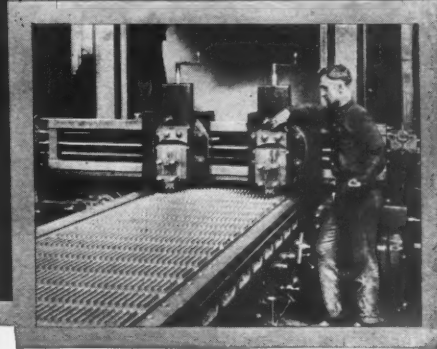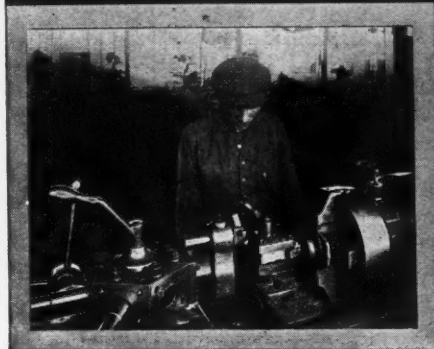
EQUALIZING PIN CHUCKS

The daily output of a chucking machine under present-day production methods is governed largely by the time required for chucking the work. In many instances, where comparatively long pieces must be chucked on the inside of a cored hole, the use of equalizing or compensating pin chucks of the type illustrated will result in a big increase in production. A driver for rotating the work against the cutting tools should be used in most cases in conjunction with the expanding pins.

The chuck shown in the top view of the illustration is of the combination push-out and draw-back type for use on a screw machine or turret lathe equipped with an automatic chuck mechanism. This chuck is operated by the lever ordinarily used in connection with the regular type of spring collet. It will be noted that the finger holder A is threaded to fit sleeve B, which, in turn, is threaded to fit the coupling on the draw-back plunger C. At the forward end of plunger C is a 30-degree angular surface around which three pins E, spaced 120 degrees apart, are seated. These pins are held or guided by holes drilled through the body of the chuck. It is obvious that the forward movement of plunger C will allow pins E to contract so that the work can be removed.

The chuck fingers D exert pressure on bar F. which, through cap G and sleeve H. moves plunger L forward. The angular seat at the forward end of this plunger forces the pins K (of which there are three located 120 degrees apart) outward. Now if pin E comes in contact with the work first, the backward movement of sleeve B is stopped, but sleeve
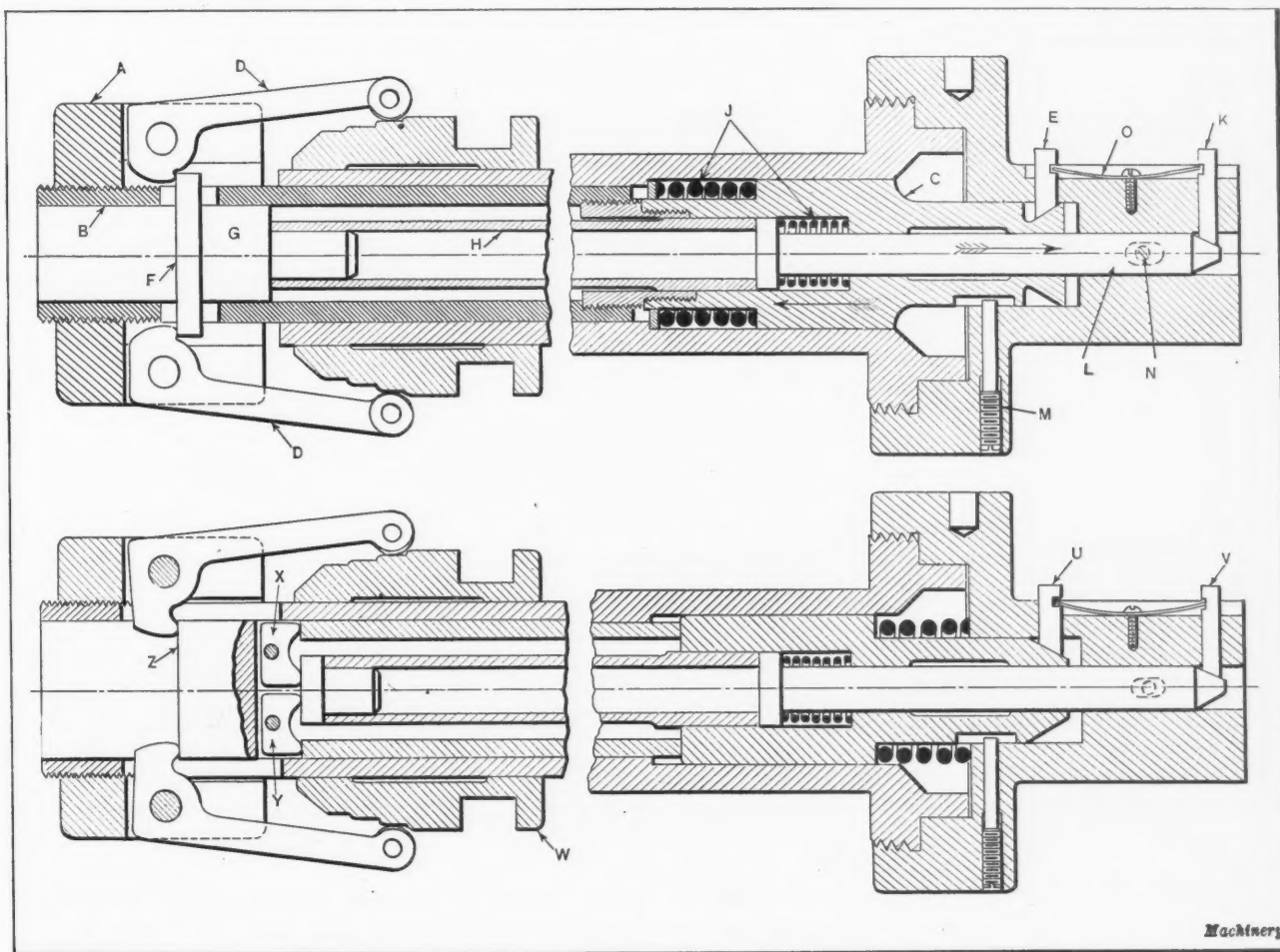
Equalizing Pin Chucks for holding Work having Cored Holes

H continues to move until pin K is against the work, at which point the pressure exerted by the fingers D is equalized between the two sets of pins E and K. The screws M and N are fitted loosely in blind keyways so that they limit the releasing movement of the two coil springs J. The flat spring O causes the pins to contract or move inward as the plungers recede.

The chuck shown in the lower view is of the same type as that just described except that the push-out mechanism is used throughout. The equalizing device consists of two rockers X and Y. In some instances where a large amount

Fig. 1. Successive Operations in producing Brass Knob

of expansion is required, it is necessary to increase the length of the fingers from the fulcrum to the point of contact with cap Z. To insure concentricity, the outer ends of the pins U and V should be ground (while the chuck is in place on the machine) to the correct diameter for the work. In grinding the pins, the automatic chuck fingers should be placed on the first or second step of the collar W. This also applies to the chuck shown in the upper view. Chucks of the types described will be found to be both rapid and reliable, and they can be applied to many classes of work.

Elkhart, Ind.   I. F. YEOMAN

DIE FOR BULGING BRASS KNOBS

The dies described in the following served to greatly simplify the production of brass knobs of the size and shape indicated by the view at the extreme right-hand side of Fig. 1. Fig. 2 shows what may be termed a reducing die, and Fig. 3 a bulging die. Previous to the development of these two dies, ten operations were required to complete the brass knob. With the improved dies, the number of operations was reduced to four. In the old method, the operations were as follows: (1) blank and draw; (2) redraw; (3) anneal; (4) redraw; (5) trim in the lathe; (6) fill with paraffin; (7) bulge; (8) melt out paraffin; (9) anneal; and (10) bulge.

In the new method. the first operation is to blank and draw, the same as in the old method. The second operation of redrawing is also the same, but in the third operation the die shown in Fig. 2 is employed to reduce the open end of the shell to a diameter of 1 11/16 inches, as shown in Fig. 1. After the third or redrawing operation, the shells are bulged to their final shape in the die shown in Fig. 3. With the new method the use of paraffin is eliminated, and no annealing of the shells is necessary. It will be noted that the outside diameter of the large, or closed, end of the shell after the completion of the third operation is the same as the outside diameter of the shell as produced in the second operation.

The reduction of the open end of the shell leaves a bulge at the closed end that can be readily enlarged or bulged out to the desired size and shape by the die shown in Fig. 3 without producing wrinkles. After the bulging operation, the outside of the open end of the knob is threaded. It was found that much better threads were produced after the new method had been adopted, due to the elimination of the annealing operations.

The construction of the dies hardly requires any further explanation than that furnished by the illustrations. Fig. 2 shows the reducing die in the closed position with the work in place. As the die member A descends, it comes in contact with the pad B, so that the work is completely enclosed when the reducing action begins. The downward movement of the press ram causes die A to press the open end of the work around the mandrel C. On the up stroke of the press, rod D strips the work from the upper die member. The plug E is fitted into the die-shoe F, and has its upper end formed to fit the contour of the work.

Referring to the bulging die shown in Fig. 3, part A is the bulging punch; part B, the die ring; and parts C and D, the knock-out studs that force the completed piece up out of the die ring after the bulging operation is completed.

Lansing. Mich.   HARRY B. CLARK
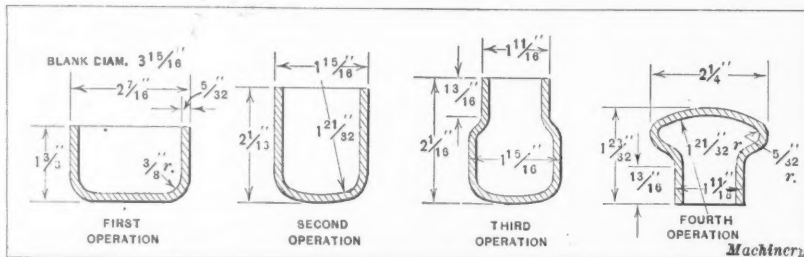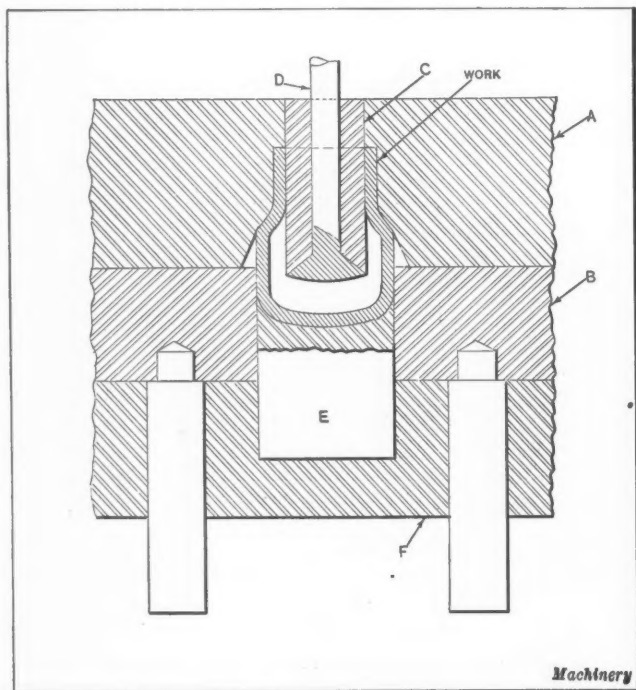
Fig. 2. Reducing Die which performs the Third Operation indicated in Fig. 1
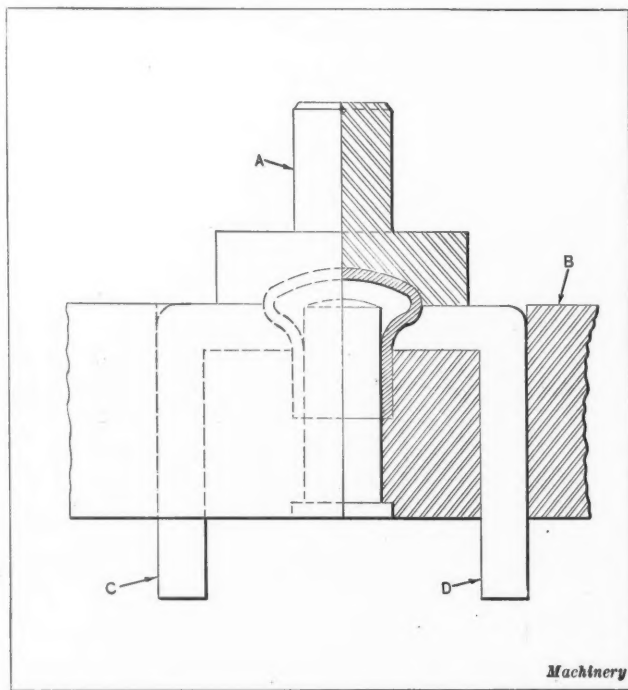
Fig. 3. Bulging Die employed to perform the Fourth Operation on the Brass Knob

THREAD MILLING FIXTURE

The milling fixture shown in the accompanying illustration was designed by the writer for milling the ½-inch pitch threads in special screws of the type shown in heavy dot-and-dash lines in the illustration. The work is held in a standard collet A, which is a sliding fit in spindle J. The required feeding movement is obtained by turning handle V. The collet is closed by the action of draw-bar L, which is drawn in by means of handwheel K. Bushing E, which is a push fit in the cast-iron base C, serves as a bearing for the worm-wheel M. It will be noted that the worm-wheel hub is provided with clutch teeth and that it is retained in position by the shoulder on head d on bushing E. Bushing E, in turn, is held in place by threaded collar B, and is prevented

O is provided to keep the clutch faces in contact. The ball handle V is pinned to spindle T, and worm W is also secured to the same spindle by means of key Q.

The ratio of the worm and worm-wheel is 40 to 1; that is, forty turns of handle V are required to obtain one revolution of worm-wheel M. In setting the fixture, part J is screwed out until dimension a is equal to the length of the thread to be cut, shoulder b on part J acting as a stop. The cutter should now be in its starting position, and the fixture having previously been set to the angle corresponding to the helix angle of the work, should be clamped to the machine table. Elongated slots are provided in the base to facilitate setting. The quick return of the spindle to the starting position is accomplished by withdrawing clutch Y by means of the handle on part G, and screwing spindle J back again
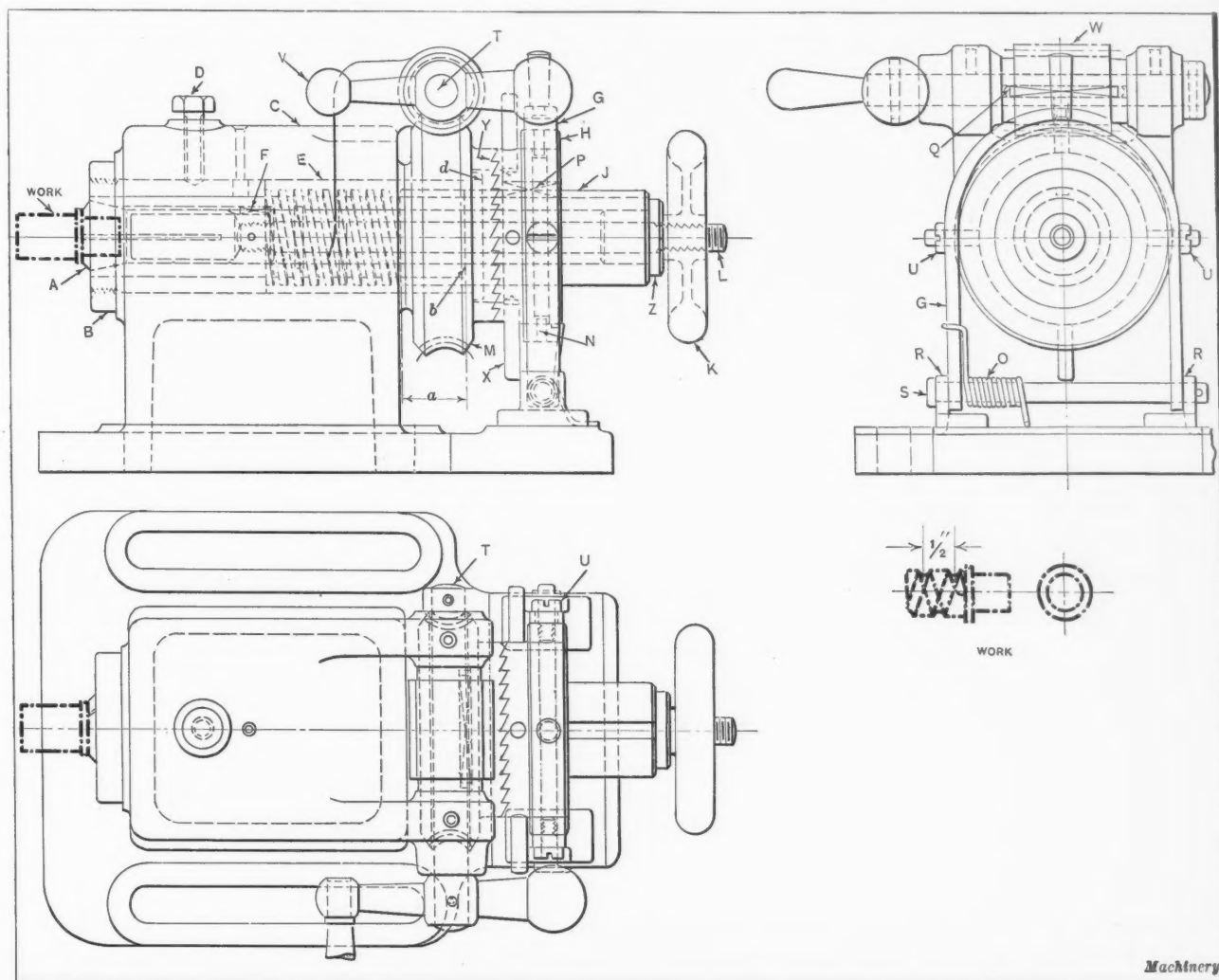
Fixture designed for Thread-milling Operation on Control Screws

from rotating by set-screw D. An internal double thread of ½ inch lead, which corresponds with the pitch of the worm, is cut in part E. Thus when spindle J is revolved by turning handle V, the work will be advanced ½ inch per revolution.

Part J, which is threaded to fit the thread in E, is bored out to accommodate collet A and bushing Z. Keyways are provided in J for the collet key F and for the key P in clutch Y, which is a sliding fit on part J. Ring H is a slip fit over clutch Y, and has two pins N driven into it which project through into a groove cut in the clutch, so that it is held in place in such a manner that it permits the clutch to be rotated.

The U-shaped piece G is fitted over part H, and is fastened to it by shouldered screws U. These screws pass through elongated slots in part G, which is fulcrumed on pin S. It will be noted that pin S is supported by brackets R. A spring

to the starting position. The pins X which project radially outward from clutch Y provide a means of turning the spindle J.

Winnipeg, Canada   J. T. LONGDON

FLOATING BASEPLATE FOR BOX TYPE DRILL JIG

When work is drilled in a box type of jig such as shown at A in the accompanying illustration, it is customary to clamp a pair of parallels to the drilling machine table and slide the jig between the parallels in order to prevent it from turning when the drill breaks through the scale at the bottom of the work. While this arrangement is satisfactory when only one hole is to be drilled or when several holes are to be drilled in the same straight line, it is not suitable when the holes are staggered.
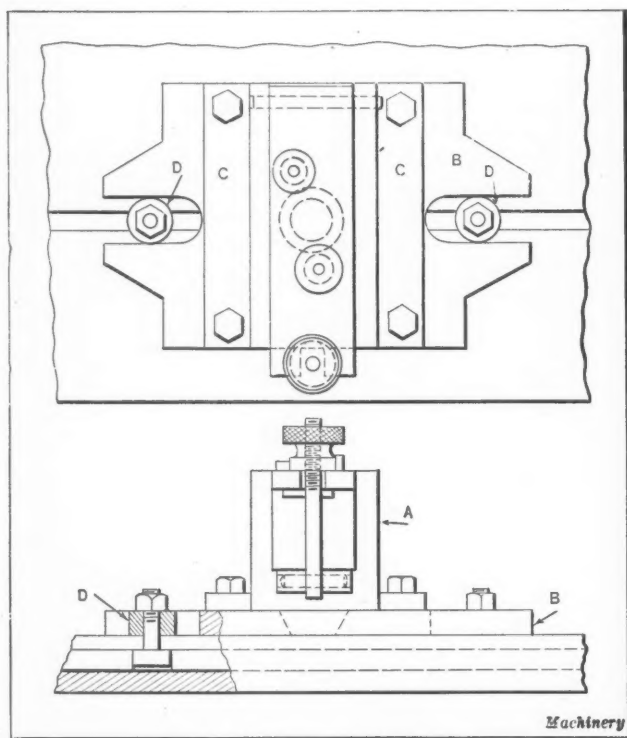
Box Type of Drill Jig mounted on Floating Baseplate

In order to facilitate drilling work with staggered holes, the drill plate here described was designed and used. A plate B of cast iron, planed on both sides, is fitted with two parallels C. These parallels are so spaced as to allow jig A to be moved freely in and out. The plate B is made with two slotted extensions which are smoothed out with a file so that the slots are a good sliding fit on the two collars D which are clamped on opposite sides of the drilling machine table by bolts placed in the table T-slot. With this arrangement the drill jig is allowed to float or to have a sliding motion in two directions at right angles to each other. It will be noted that the floating action of the baseplate is similar to that of an Oldham coupling.

With the floating baseplate described, all strains due to the puiling of the drill are equalized, so that drill breakage is reduced to a minimum. Work drilled with the aid of the floating baseplate will have straight holes, and the wear on the drilling machine table, drills, and drill jig bushings is lessened. When the plate B has become worn, it can be quickly and cheaply trued up by planing.

Allentown, Pa.　　　　　　　　　　JOE. V. ROMIG

SHRINKAGE IN CASTINGS

As an apprentice learning the trade of patternmaking, the writer was taught by an experienced journeyman that ribs were put on a pattern to prevent warping and to add strength to the casting. The journeyman molder differed with the patternmaker on this point, however, claiming that all ribs have a tendency to cause the casting to bend or curve due to the shrinkage strains in the ribs, if they are as thick as, or thicker than, the plate itself. If the ribs are thinner than the plate, they will become cool first, and by resisting the shrinkage strains at the bottom of the plate cause it to curve upward or "dish" on the top surface.

In the case of flat plates, they will usually be found hollow on the top. This is due to the following causes. The top and bottom faces, together with the outside edges, become set first, because they are first to come in contact with the mold. Thus the center of the plate is left soft after the bottom has become set. When the center shrinks, a severe strain is exerted on the plate, which has a tendency to reduce its cross-section area and thus bend the plate. This strain is resisted by the cool metal at the outer edges.

On the other hand, if the cope is thin, the heat will radiate rapidly, on the top side, causing the outer or top side to set first. As the under side will then set last, it will drag the top side over with it, causing the top surface to "round" up and the bottom to "dish."

If the pattern is accurately made and the cope and drag are of the same thickness and both are evenly rammed, there is no reason why a true casting should not be produced. If the plate has an ogee rib projecting downward around the edge, it will very likely be depressed on the top surface when the casting cools. This is caused by all the metal except that in the corners becoming set at the same instant. The corners, which contain the most metal, will shrink last. This causes the top side of the mold to be pulled toward the plate, which being soft, although set, will be forced downward at the edge, thus permitting the strain set up within the plate, as previously mentioned, to distort the casting further. It is claimed by some that it is a good plan to round the ribs sufficiently to compensate for the shrinkage, so that a casting with the desired flat surface will be produced. Just how much the ribs should be rounded, however, the writer has never been able to determine, and it has been his experience that ribs are of no assistance in producing a flat and true casting.

Kenosha, Wis.　　　　　　　　　M. E. DUGGAN

SPRING-BENDING DEVICE

The device shown in the accompanying illustration was made up for use in bending a large quantity of springs made from 1- by ⅜-inch steel stock. One end of each spring was to be bent to a U-shape, as indicated by the dot-and-dash lines at A. The tool consists essentially of a solid round piece of stock B and a collar C which is secured to a bending lever E by the screw D. In use, the tool is gripped in the jaws of a vise, as shown, with the collar C resting on top of the jaws. One end of the spring steel is heated and inserted between the vertical section of the bending lever and the piece B so that the end F projects the correct distance beyond the bending lever. The lever is then pulled or drawn around in the direction indicated by the arrow G so that the end F is bent around part B to the position indicated at A. During the bending operation the unheated end of the stock is held stationary by means of the tongs used to hold the work in the heating furnace.

Rosemount, Montreal, Canada　　　　HARRY MOORE
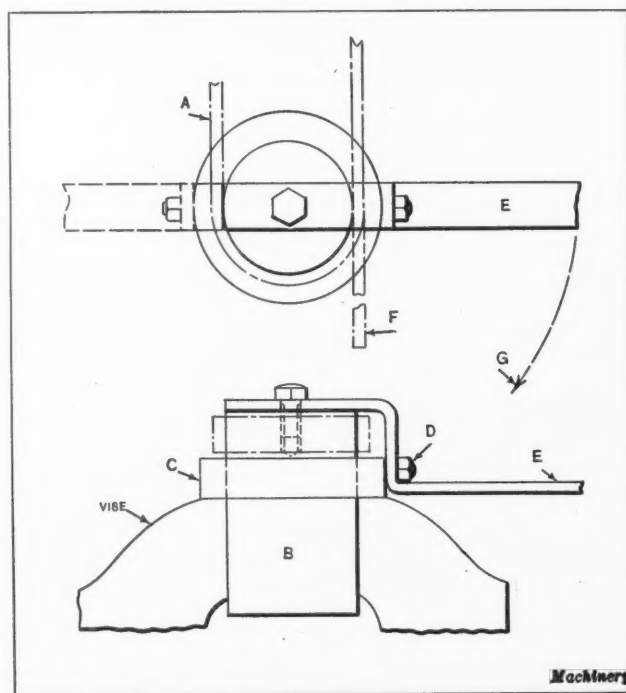
Device used in making U-shaped Bend at the End of Heated Spring Stock

ARRANGING TECHNICAL LITERATURE FOR READY REFERENCE

The following is a description of the system used by the writer in arranging the numbers of MACHINERY so that they form a handy and easily accessible library of mechanical information. The monthly copies of MACHINERY are not allowed to accumulate on the reading table or desk. As soon as four copies have been received and read, the staples are removed from the backs of each. Next the index page is

MACHINERY'S LETTERS ON PRACTICAL SUBJECTS

No.	Index of Subjects	Number of Pages	Page Number	
1	Turning	4	2	1
2	Boring	4	6	2
3	Planing	4	10	3
4	Milling	4	14	4
5	Drilling	4	18	5
6	Splining	2	22	6

Fig. 1. General Subject Index prepared for Each Section of Bound Volumes of MACHINERY

carefully removed, and after all the reading matter is taken out, the index is placed next to the first page. The four copies are then bound together, making one complete book. The cover used is the one from the first magazine in the book. With this plan there will be three books a year, having four magazines each, starting with the September number, because the volume starts with September and the pages are numbered accordingly.

Next, a general index book having at least thirty-six lines to the page is prepared, the first page being arranged as indicated in Fig. 1. The numbers in the column at the extreme right-hand side of this index page indicate the page on which the subject indexed will be found in the complete list of articles which is made up after the first general index has been completed. The second column to the left, gives the number of pages devoted to the subject indexed which is listed in the third column. The column at the extreme left gives the number of the complete index page on which all the articles under the general title or heading are indexed. Reference to Fig. 2 will show the arrangement of one of the latter index sheets.

Referring to Fig. 2, the first column at the right gives the page number; the next column, the number of the volume

TURNING

Month	Year	Title of Article	Vol.	Page	
Sept.	1915	Turning Tool-Holders	22	6	1
,,	,,	Valve Part Mfg. On Bench Lathe	,,	49	

Fig. 2. Form of Index used to list all the Articles under each General Heading

(not of the year); the third, the title of the article; and the fourth and fifth, the year and month, respectively. Tabs are placed on these index sheets as shown, so that when the cover of the index book is opened the tab will come opposite the subject indexed in the general index, as shown in Fig. 1. It will be understood that the tabs 1, 2, 3, etc., shown in Fig. 1, are not attached to the sheet illustrated in this view, but project from separate sheets like the one

shown in Fig. 2. When the copies are bound as described, all articles are listed under their proper headings in the index book, with the month, names of articles, volume, and page numbers. A system such as described results in making the volumes of MACHINERY into a text-book that explains the best up-to-date devices and methods in use.

East Walpole, Mass.   JAMES A. KIRK

DRAW-FILING AND STONING FIXTURES

Straight, accurate filing is an art that few mechanics thoroughly master. It is true that all good mechanics can do fairly satisfactory work with the file; but when the accuracy often required in making gages, templets, and dies is necessary, the average machinist finds that he needs some assistance in the form of a guiding block or tool. After such work is hardened, it must frequently be stoned, and here again, difficulty is experienced in maintaining angularity, straightness, etc. To render work of this nature comparatively easy, the device shown in the accompanying illustration was made.

It will be noted that a short section of a flat file A is clamped in the device for draw-filing flat or convex surfaces. In the lower view, a round file B or oilstone is clamped in
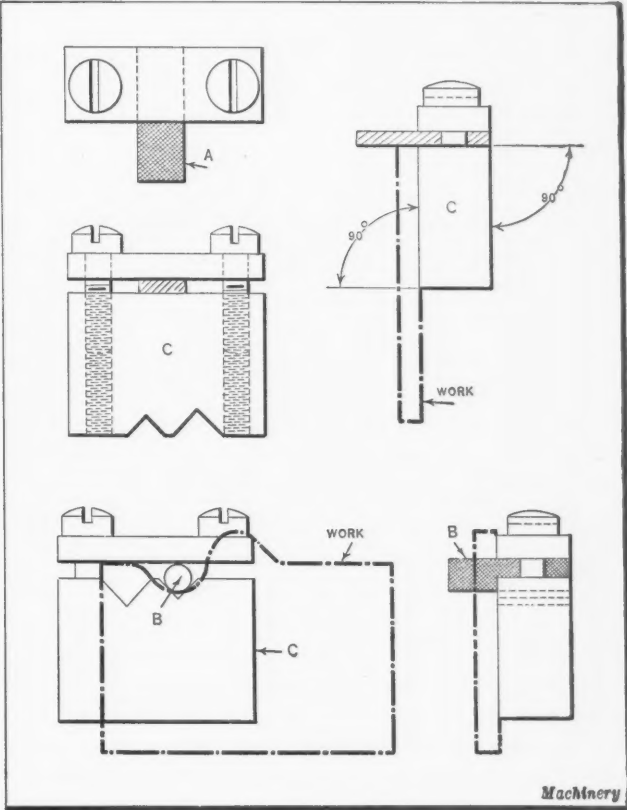
Guide Blocks for Use in Draw-filing

one of the V-shaped openings in the opposite side of block C for filing or stoning concave surfaces. The V-shaped cuts also permit the clamping of files and oilstones of other shapes. The body C of the device should be hardened and accurately ground. If found desirable for die relief work, the angle of the clamping face may be made to suit the clearance desired.

Tacoma Park, D. C.   G. W. NUSBAUM

* * *

In a paper on "Maintenance Effects of Automotive Electrical Equipment Standardization," presented before the Chicago service meeting of the Society of Automotive Engineers, A. H. Packer estimated that by standardizing electrical equipment parts for automobiles it would be possible to reduce armature stocks to the extent of $2,000,000.
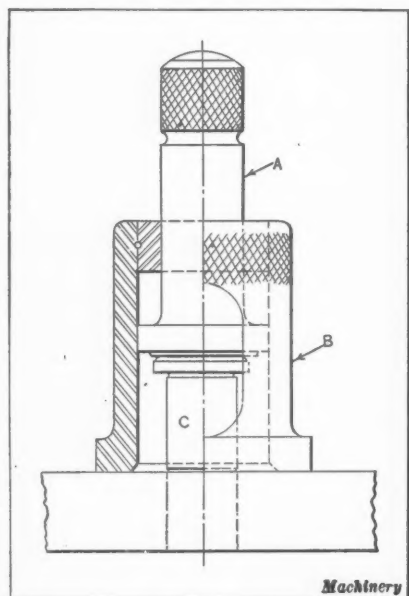
Shop and Drafting-room Kinks

SAFETY DEVICE FOR ELEVATOR

The causes of factory elevator accidents are numerous, but one of the most common is carelessness on the part of the person injured. Many persons have been struck on the head by the descending car while looking down an unguarded elevator well. A simple safeguard against such accidents consists in suspending a row of light chains from the lower front edge of the car. If these chains are made about six feet in length, they will give ample warning of the descent of the elevator, and will serve to prevent many a serious accident in places where safety doors are not provided.

P. R. H.

DEVICE FOR DRIVING BUSHINGS

The bushing-driving device shown in the accompanying illustration is designed to keep the bushing in proper alignment with the hole into which it is being driven. This lessens the danger of shearing the hole or injuring the bushing, which sometimes occurs when it is driven into place by a piece of babbitt or a soft-faced hammer without being guided.

It will be seen that the device consists essentially of a plunger A and a body B having a large opening in the side through which the position of the bushing may be observed. The plunger A, which is used to drive the bushing C into place, is held in a vertical position by body B. The lower end of the plunger is carefully machined at right angles to the axis, so that there will be no tendency for it to tip or throw the bushing out of alignment during the driving operation.

Ontario, Cal.

J. HOMEWOOD

Device for driving or seating Bushings

DETERMINING THE LENGTH OF A FORMED ROD

The method here described for determining the length of the piece of stock required for a formed part, such as shown in the accompanying illustration, is sufficiently accurate for all practical purposes, and may be employed for pieces of various shapes. Referring to the illustration, angles D, E, and F are generally known, and if not known, they may be readily measured with a protractor. The circumference (denoted by C in the following formula) may be found by multiplying the diameter L by 3.1416. The length of the center line intercepted by the arc of angle F is found by the formula $\dfrac{C \times F}{360}$.
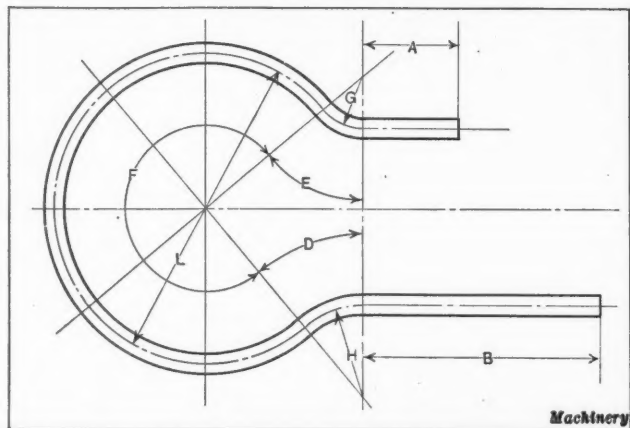
Diagram illustrating Method of determining Developed Lengths

The lengths of the center lines intercepted by the arcs having radii G and H may also be found by the use of this formula. To the results thus obtained are added the lengths A and B of the straight parts.

Lansing, Mich.

C. F. POWERS

PUNCH FOR LAYING OUT TEMPLETS

The punch shown at A in the accompanying illustration has been found very useful in laying out blanks, templets, or anything that is required to be cut from sheet or plate metal by drilling a series of holes as indicated by the punch marks at B. Drill rod from 3/16 to ½ inch in diameter has been found suitable for punches of this kind.

In making the punch, it is simply necessary to chamfer the end of the drill rod, and then turn or bore a recess about 1/32 inch deep, as shown, leaving a small point C at the center. Only the machined end of the punch should be hardened, the upper end of the shank being left soft. After laying out a series of holes on a piece of metal, as shown at B, the workman usually employs a regular prick-punch to increase the depth of the central prick-mark, so that it will be an easy matter to start the drill.

Ypsilanti, Mich.

FLOYD GRAVES
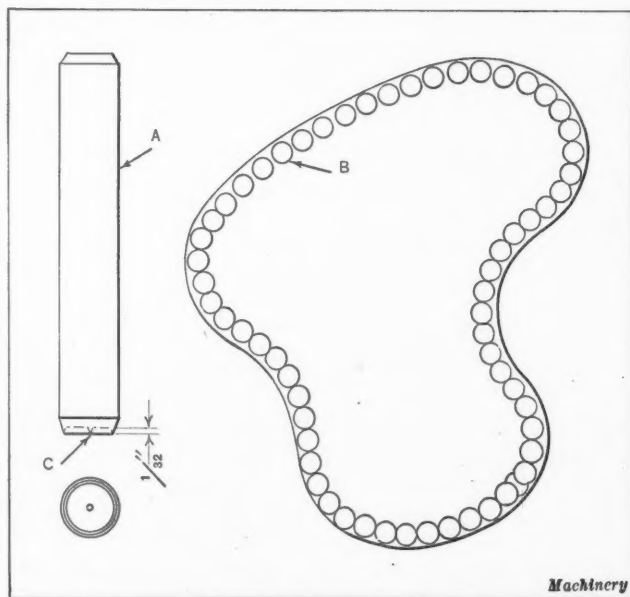
Lay-out Punch and Diagram illustrating its Use

Questions and Answers

P. W. N.—In MACHINERY'S ENCYCLOPEDIA, Vol. VI, page 429, a variable-speed transmission is shown in Fig. 33. I am designing a mechanism in which I could make use of a variable-speed transmission of this type, and if this transmission at the present time is being made for the market by any manufacturer, information to that effect would be appreciated.

FORGING BRASS

A. B.—I have seen recently references in the technical press to brass forgings. Textbooks generally state that brass cannot be forged. Please explain the use of the term.

A.—Brass cannot be forged in the ordinary sense. Hot brass cannot be hammered into various shapes on an anvil the same as iron or steel, nor can drop-forgings be made from it under a hammer; but, by means of heavy pressure, brass parts can be shaped in dies, and these parts are frequently called die-pressed brass forgings. Copper and copper-zinc alloys such as brass cannot be forged in the ordinary sense, because the metal will not flow the same as iron or steel, but heated brass can be caused to flow if red-hot blanks are placed in dies that are squeezed together in a hydraulic or power screw press, the latter type being preferable to the former because of its quick action. The methods used for producing die-pressed parts from brass are described in two articles that have appeared in MACHINERY: "The Production of Die-pressed Castings," January, 1916; and "Making Brass Forgings," December, 1920.

ROLLING THREADS ON THIN SHELLS

H. D.—There are a number of questions relating to the rolling of threads on bottle tops, lamp bases, and similar articles that I would like to ask:

1. How is the templet for making the tool with which to cut the rollers laid out?

2. How deep should the thread be cut in the roller? Are there standard dimensions for bottle top threads and for lamp socket threads?

3. How much smaller than the inside of the shell must the spindle roller be?

4. Is there any difference in the diameter of the rollers? On some thread rolling machines, I am told, the upper or outside roller is made as large as three times the lower or spindle roller.

5. Is there any formula for determining the outside diameter of the shell before it is rolled? For example, if a shell with a thread already rolled on it is available as a sample, how would one know what the outside diameter of the drawn shell should be, that will finish up to the same thread diameter?

These questions are submitted to MACHINERY'S readers.

PRESSURE REQUIRED FOR ASSEMBLING A CORLISS ENGINE CRANK-DISK PIN

S. S.—Recently the crankpin became loose on a Corliss engine which is used to drive the saw mill of which I am shop foreman, and it was my duty to supervise its replacement. The diameter of the hole in the crank disk was 8 inches and the length of the hole was also 8 inches. The pin was made 0.012 inch over-size to obtain a drive fit, and assembled in place by ramming with a shaft. I would like to know about what pressure would be required for assembling the pin by means of a hydraulic press if such a machine were available. Is there a formula for determining this?

A.—The pressure cannot be determined with great accuracy, due to a number of factors. However, the formula at the top of page 885 in MACHINERY'S HANDBOOK will give an approximate value. According to this formula,

$$P = \frac{A \times a \times F}{2}$$

in which

P = ultimate pressure required, in tons;

A = area of surface in fit;

a = total allowance in inches; and

F = pressure factor based on assumption that diameter of hub is twice diameter of bore, that the shaft is made of machine steel, and that the hub is made of cast iron.

Now, as the diameter of the crankpin is 8 inches and the length of the hole 8 inches, $A = 8 \times 3.1416 \times 8 = 201.06$. According to the information given in your letter, $a = 0.012$, and from the table given at the bottom of page 884 of MACHINERY'S HANDBOOK, $F = 55$.

Substituting these values in the formula,

$$P = \frac{201.06 \times 0.012 \times 55}{2} = 66.35 \text{ tons, approximately.}$$

RENEWAL OF AN ABANDONED APPLICATION FOR LETTERS-PATENT

F. A. D.—I have noticed in recent numbers of MACHINERY, answers to questions regarding patents and trademarks, and would appreciate your advising me what constitutes an "abandoned application for a patent" and whether or not it can be renewed.

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

Abandonment of an application for letters-patent may be brought about in several ways. It is well known that the Patent Office is seriously behind in its work due to its small staff and large volume of work handled. In order that the calendar may be brought as nearly up to date as possible, more or less stringent rules of procedure have been adopted, and so an application is deemed to be abandoned when all its essential parts have not been filed complete and ready for examination within one year. An application is also considered abandoned when the applicant has failed to prosecute it within one year after any action of which notice has been given. An abandoned application may be revived as a pending application when it can be shown to the satisfaction of the Commissioner of Patents that the delay was unavoidable.

An application may be abandoned by the applicant and his assignee if there is one, by filing a written notice to that effect. In the course of its prosecution through the Patent Office, an application may have a number of patents cited against it, and there may also be certain matters in the record that the inventor would not care to have known after the issuance of the patent. At that time all matters relating to the application become public property and are open to the inspection of all desiring to know what transpired during its prosecution. In such a case, the application is frequently abandoned and a new one corresponding exactly with it, in the shape and form allowed by the Office, is filed and granted without criticism, and with an absolutely clean score. An abandoned application for patent may be renewed, but a new petition, specification, oath and filing fee is required. The original drawings may be used under certain conditions.

MILLING ATTACHMENT FOR ENGINE LATHE

By JOE V. ROMIG

The milling attachment shown in the accompanying illustration is a useful addition to the equipment of any engine lathe. This attachment was originally designed for milling the flutes or grooves in taps and reamers, but many uses will be found for it in small shops having a limited number of machine tools, or where the only machine tool equipment consists of a lathe. Small pinions and gears can be cut, and flats and irregular contours can be milled the same as on a standard milling machine by employing the milling attachment. The work can be fed to the milling cutter by using the power cross-feed of the lathe carriage. The angular position of the work required for milling the flutes in tapered taps and reamers is obtained by tilting the attachment on the vertical supporting member of the carriage H.

The design of the attachment and its operation are as follows: A simple indexing head provided with an index-plate A and an indexing pin B is mounted near the back end of bar C. The support E is held in place by set-screw F, which provides for adjusting the tailstock center to the same height as the indexing head center. The indexing head

on which the milling cutter is mounted. A knurled-head screw K is used to make the vertical adjustment. The rotation of the spindle is reversed, as indicated by arrow L, when the milling attachment is used. Feeding movements in three directions may be obtained by using the vertical adjusting screw K of the attachment and the cross and the longitudinal feeds of the lathe. Index-plates having any number of holes can be made up as required, the most useful being those having sixteen, eighteen and twenty holes. The outer edges of the index-plate should be knurled to provide a good grip for the operator.

* * *

MACHINING PISTON-VALVE FOLLOWER ON THE TURRET LATHE

Up to the present time, turret lathes have not been extensively employed in railroad shops. In the comparatively few shops where they have been installed, however, substantial savings have been noted in the cost of machining such parts as cross-head pins, wrist-pins, stoker pins and washers, steam pistons, air pistons, bull rings for piston valves, knuckle-joint pins, etc. In Fig. 2 is shown the tooling equipment employed in machining piston-valve followers on the Libby turret lathe manufactured by the International Ma-
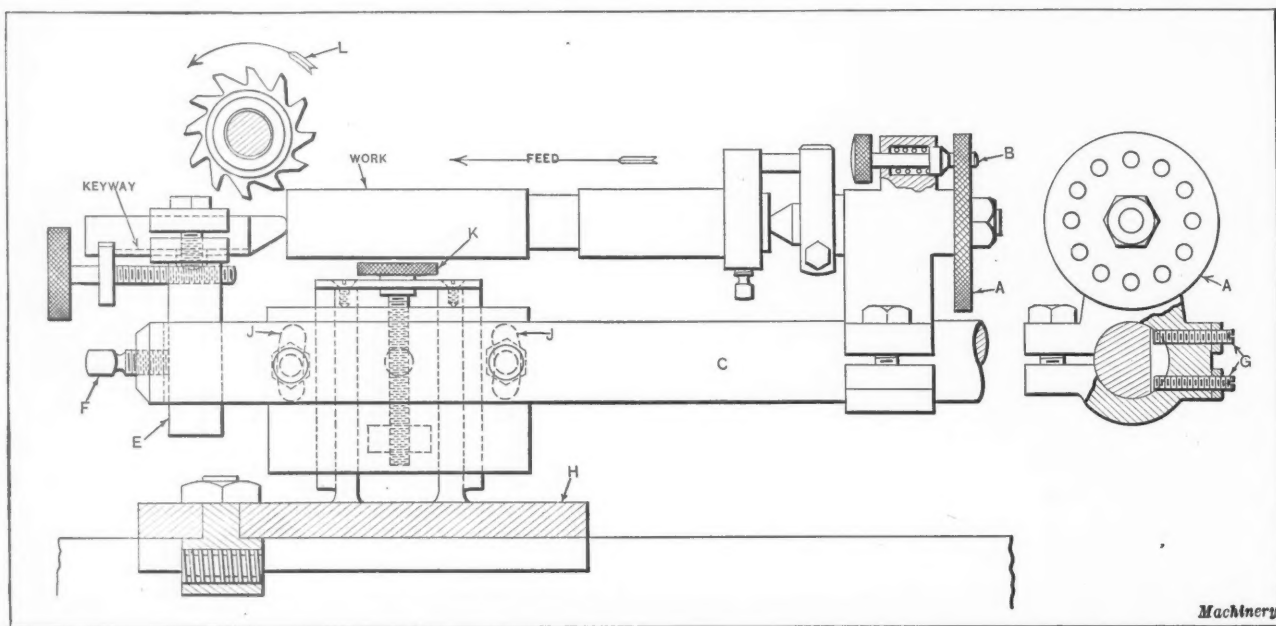
Lathe Attachment for milling Flutes in Taps and Reamers

center is turned integral with the spindle, and carries the index-plate A which is held in place by a key and a nut. The indexing pin B, which slides in a hole in the top of the indexing head body, permits a quick yet positive spacing of the work when used with index-plates such as the one shown.

The indexing head is clamped to bar C and adjusted to a vertical position by means of the adjusting screws G which engage the flat surface milled on the side of the bar. The bar slide, with the head and tailstock assembled on it is mounted on the vertical supporting member of carriage H so that the indexing head is at the front side of the lathe. The bar C can be pivoted on its support and clamped in any angular position within the tilting range of the device by means of the bolts in the radial slots J. The carriage H can be fitted to the cross-slide shears as shown, or a vertical slide support can be made in the form of a T-shaped casting and clamped to the top of the compound slide rest of the lathe.

For accurate or heavy work the fluting cutter spindle should be supported by both the headstock and the tailstock centers of the lathe. This necessitates making the vertical slide of the attachment low enough to pass under the arbor

chine Tool Co., Indianapolis, Ind. The dimensions of the finished piece are shown in Fig. 1. Approximately 3/16 inch of stock is removed from surface C, 1/4 inch from surface D, and 1/8 inch from the face E of the flange. The chuck used to hold the work consists of three special inside jaws. These jaws, one of which is shown at A, Fig. 2, grip the rim of the work between the spokes.

First Operation

In the first operation, the tool B, which is held in the toolpost, rough-faces the flange and the rim and rough-turns the outside diameter. This operation is completed in three minutes. In turning surface D, the spindle is run at a speed of 23 revolutions per minute, and a feed of 1/16 inch per revolution is employed.

Second Operation

The second operation consists of drilling the hub from the solid with a 1¾-inch high-speed drill F. The drilling operation is performed in one minute, using a feed of 1/64 inch per revolution of the work and a spindle speed of 60 revolutions per minute. The drill-holder G is securely fastened to the turret of the lathe by means of four cap-screws.

Third Operation

In the third operation, the hole drilled through the hub in the second operation is rough-bored to a diameter of 2 inches with an adjustable boring-bar *H* mounted in a standard type G head. It will be noted that the boring-bar has a piloted end which is supported and guided by a bushing *J* located in the spindle. The boring operation is completed in ¾ minute, using a feed of 1/32 inch and a spindle speed of 174 revolutions per minute.

After the boring cutter has passed completely through the hub, the outside diameter is rough-turned and the rim and flange rough-faced. As the turret is advanced toward the work, cutter *K* rough-turns the outside diameter. At the completion of the forward movement of the turret, when it has reached the positive stop, cutters *K* and *L* will

Fig. 1. Piston-valve Follower

have rough-faced the flange and the rim. The time required for this facing and turning operation is two minutes. The feed is 1/16 inch per revolution of the work, and a spindle speed of 23 revolutions per minute is employed.

Fourth Operation

The fourth operation consists of finish-boring the hole in the piston-valve follower hub. An adjustable boring-bar mounted in the turret-head is used for this operation. The time required is 1/2 minute, using a feed of 1/16 inch and a spindle speed of 174 revolutions per minute.

Fifth and Sixth Operations

In the fifth operation, the outside diameter of the work is finish-turned, and the flange and rim are finish-faced. The tools used are similar to those employed for the roughing cuts taken in the third operation. A standard type G head is used to hold the tools. A pilot bar *M* which fits into a bushing *N* inserted in the finish-bored hole in the hub of the work, insures accuracy. This operation is completed in one minute, using a feed of ⅛ inch and a spindle speed of 23 revolutions per minute.

For the sixth operation, the work is removed from the chuck and placed on the face-plate arbor shown in the view at the lower right-hand corner. The pin *P* serves to drive the work while the hub is being faced by tool *Q*, which is held in the toolpost. A roughing and a finishing cut are taken, a feed of 1/16 inch being used for the roughing cut and ⅛ inch for the finishing cut. The spindle speed for this facing operation is 60 revolutions per minute. The total time for machining the piston-valve follower—floor-to-floor time—is twelve minutes.

* * *

The first instance of the automobile putting a branch line of the railway out of business has been brought to the attention of the Interstate Commerce Commission, who has authorized the New York, New Haven, and Hartford Railroad to abandon a branch line in Franklin County, Mass.
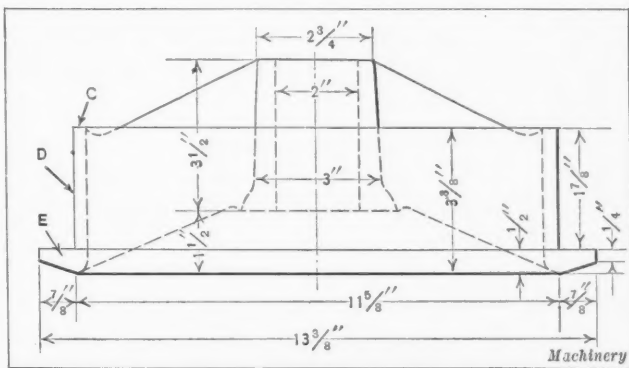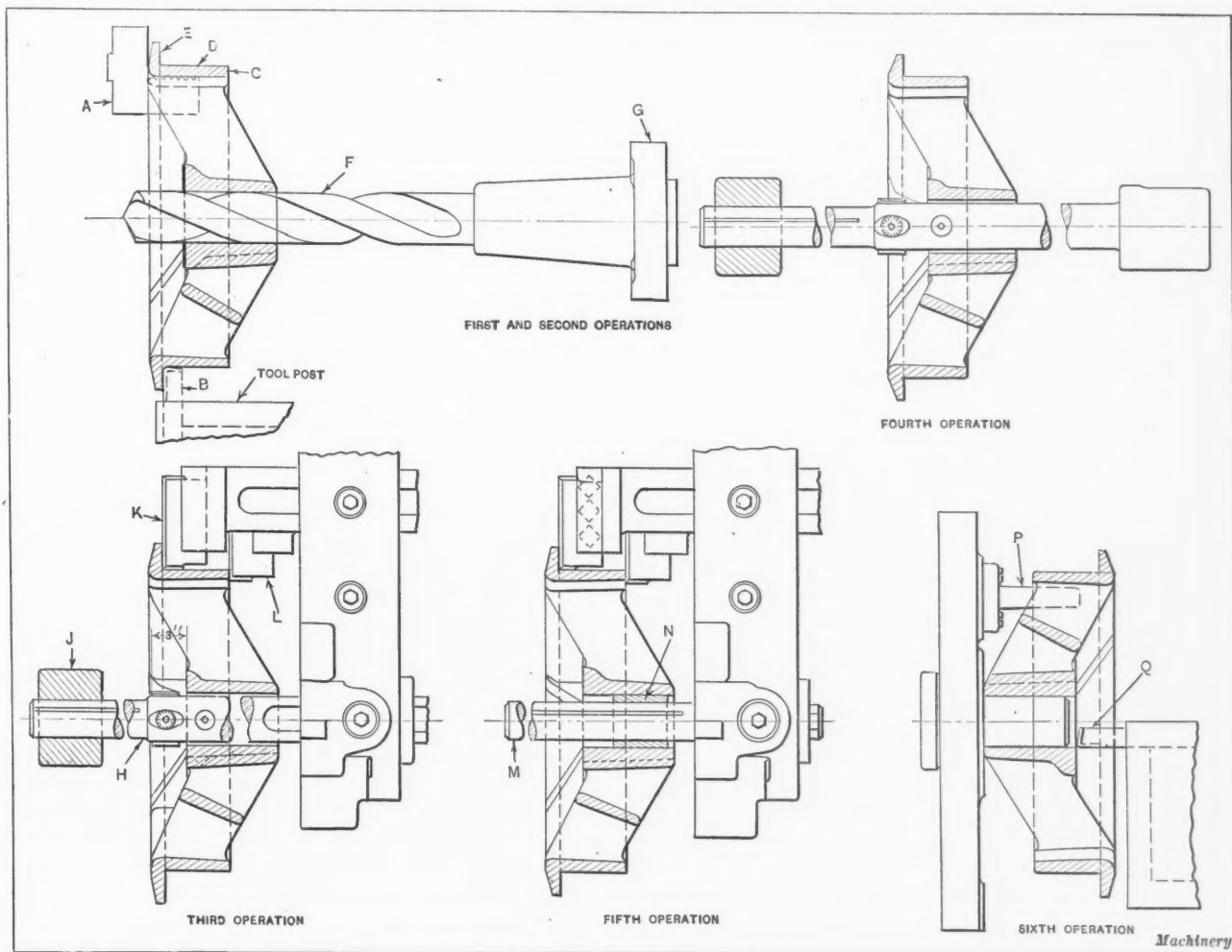
Fig. 2. Turret Lathe Tooling Equipment used in machining Piston-valve Follower shown in Fig. 1

The Machine-building Industries

IN the machine tool industry, the new business during the past two months has not equalled the orders received in the earlier months of the year;. but there is a fair number of unfilled orders on hand, and cancellations have been very few. This indicates a much healthier state in all the industries than when the demand fell off three years ago. The machine tool industry, as a whole, operates at from 50 to 60 per cent of capacity, with new orders approximating about 35 per cent of capacity. It should be remembered that the capacity of the industry, due to its growth during the war, is considerably greater than necessary to meet what might be termed a "normal" demand, such as is created by the gradual industrial growth of the entire country, and that a production of from 50 to 60 per cent of capacity is probably very nearly "normal."

As there is no great expansion taking place in other industries, it is not expected that there will be any appreciable increase in machine tool demands for some months to come, the high peak having been passed last March; but on the other hand, there has not been any serious falling off in other lines of industry, and hence there is reason to expect a fair demand for machine tools, because the scarcity of labor makes the need for improved equipment more imperative. Many well-informed men both inside and outside of the machine tool field believe that there will be quite a large replacement business in machine tools in the near future. The number of inquiries received by both manufacturers and dealers strengthens this belief.

Business in New England and Ohio

In New England, the machine tool business has been somewhat more quiet since the beginning of the summer than in the Middle Western states, and has not compared favorably with the activity in the earlier months of the year. Toward the end of July and early in August, some improvement was noticeable, and men of long experience in the industry look forward to fair business in September, as indicated by the number of inquiries now on hand. In the Ohio territory business has been more normal for this time of the year. There has been some buying by automobile firms, and more business is expected from this source in the fall; there has also been some improvement in the export business, and while the railroads are at the present time not buying very heavily except in the Chicago district, where the railroad business has been fair, there have been a number of single tools sold to the railroads.

The demand for lathes is keeping up at about the same rate as during the past six months. Some of the leading makers operate with about 60 per cent of their peak force, but it is stated that most sales are of single machines. At this time of the year the trade schools and manual training schools are in the market for lathes, and this has proved of assistance to the builders of the line of machines especially suitable for school equipment. The demand for turret lathes is following closely the general trend in the machine tool field. In the drilling machine line, the. business has been fair for production machinery. Although the quiet season has brought about the usual falling off in orders, inquiries are numerous, and requests for' production estimates indicate an increasing interest in machines that will reduce costs. The demand for sensitive drilling machines has been good. The demand for planers has been less active than for a number of other machine tools, and the same is true of milling machines, except those of the vertical type, for which there has been a better

demand. Internal and bore grinding machines have been in fair demand during the past two months.

The Automobile Industry

Contrary to general expectations, the production in the automobile industry did not fall off to a very serious extent after the first six months of the year had passed. The July production was 318,000 cars and trucks, and while August will show a still further reduction as compared with the peak figures in May, it is agreed by all engaged in this industry that the demand continues unusually active for this time of the year. The July production was at a rate of 3,800,000 cars a year, and inasmuch as the output of the year up to July 31 was 2,344,000 cars, it may well be expected that the production for the entire year of 1923 will be well above the 3,000,000 mark. The output for the twelve months ending July 31 was, in fact, 3,525,000. Ford has again set a new record by the production of 7121 cars and trucks in one day, and instead of decreasing production in July, the Ford figures showed an increase. The Ford plants have now built, in all, over 8,000,000 cars.

The conditions in the automobile field are generally satisfactory, but the manufacturers show greater caution than in the past, realizing that there will be a decline in the buying of cars in the fall. The farmers are bigger buyers than for the past three years, although the industrial sections are still buying more freely than the agricultural.

The Iron and Steel Industry

The pig iron production has been sharply curtailed, and there was a net loss of twenty-five furnaces in July. Pig iron stocks are large, because of the heavy record production in the earlier months of the year. The average production for the year, however, has been unusually high, and the present falling off in production is merely a healthy and normal sign of caution. An encouraging feature is that new August business is greater than the July volume, which in turn was ahead of June. Cancellations have been few, although there has been a number of cases of suspended deliveries. Lower prices have followed the decrease in production, and this again will help to maintain activity in the industries that would have had to proceed very cautiously with the high pig iron prices prevailing a few months ago.

The Railroad Situation

The activity of the industries in general is best indicated by the record freight carried by the railroads. During the past three months a heavier freight movement is recorded than ever before in the country's history. The railroads have made splendid efforts toward coping with this traffic, and are now in a position to carry more freight than ever before, with a larger available surplus of cars. This year, up to the first of July, 79,000 freight cars and 2000 locomotives have been put into service, and about an equal number of cars and locomotives are still on order.

In summing up the general business conditions, the Federal Reserve Bank makes the following statement: "The summer season is testing the staying qualities of our present prosperity; it is finding them not wanting. The railroads are carrying revenue freight at a rate of more than 1,000,000 cars a week—a record-breaking movement. The demand of the consumers is back of this. In 1920 shelves and store-rooms were piled with high-priced inventories; today goods are being used."

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Pratt and Whitney Lathe

THERE are a number of especially interesting features incorporated in the design of a new 16-inch lathe that has recently been brought out by the Pratt & Whitney Co., Hartford, Conn., the outstanding one being the design of the headstock. Instead of locating back-gears at the rear of the spindle, they are placed beneath it on both the geared and cone heads and are figuratively "under gears." By this design the weight of the headstock unit is centered over the bed, and the height is decreased, thus providing greater freedom of movements for the operator in filing and similar operations, as well as more light on the work. A direct-reading plate on the headstock indicates the speed at which the spindle rotates, and a plate on the feed-box shows the number of threads per inch, which may be cut with any setting of the gears in the feed-box, and also the rate of carriage feed per spindle revolution for each setting. By this means there is a constant check available on the setting for both the operator and foreman. Among other features

Fig. 1. Pratt & Whitney Lathe of New Design

are included the arrangement of the motor in the motor-driven type and the details of the carriage and apron construction.

This lathe is built in three general types, with an all-geared headstock and a motor drive; with the same all-geared headstock and a belt drive; and with a four-step cone headstock. It is primarily designed for the motor drive, in which case the power is furnished by a five-horse-power constant-speed motor. The motor is mounted on a hinged platform in the cabinet leg, as illustrated in Fig. 4, and drives the headstock mechanism through a belt connecting a small pulley on the motor shaft to a pulley on a shaft at the rear of the bed. The hinged platform is used to tighten the motor belt. Power is transmitted from the second shaft to the spindle by a friction clutch and a train of gears. The starting and stopping of the lathe is controlled by means of an overhead stop-rod which extends the entire length of the machine and which is employed to operate the clutch. A

Fig. 2. Close-up View showing the Direct-reading Plates for Spindle Speeds and Carriage Feeds
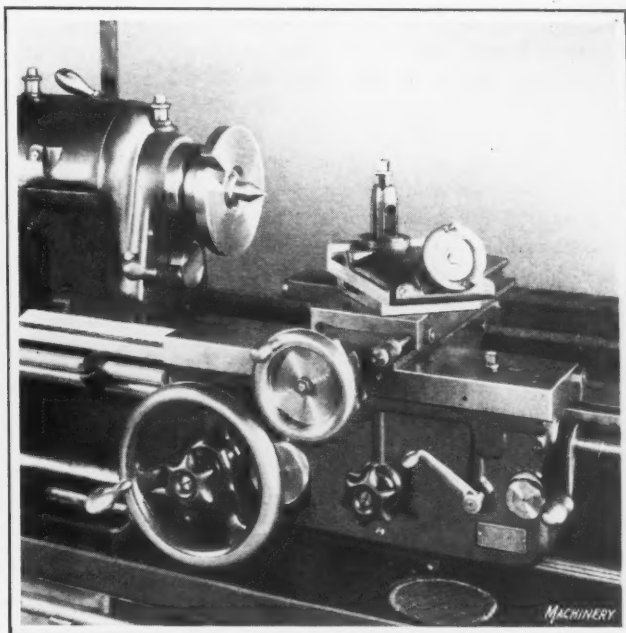
Fig. 3. View of the Carriage showing the Quick-withdrawing Device and Other Construction Details
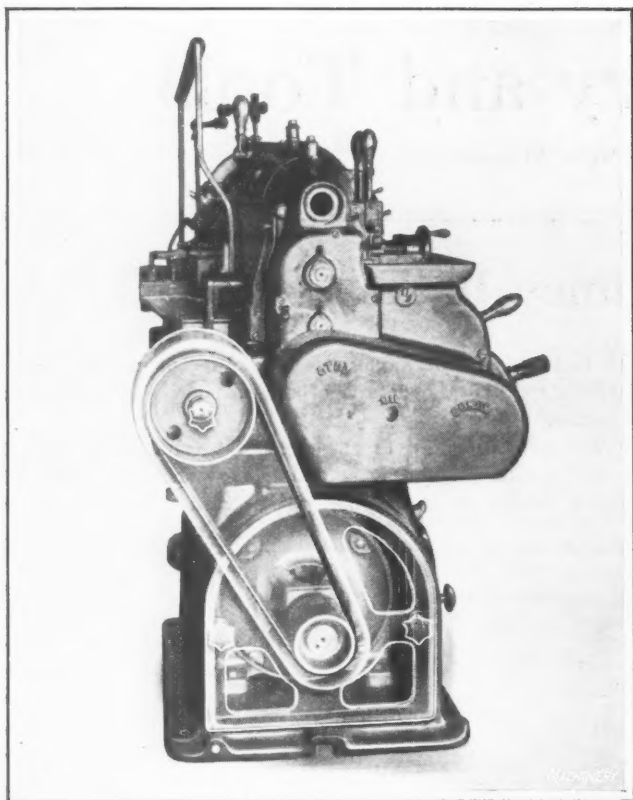
Fig. 4. End View showing Motor in Base and Headstock Construction

brake is applied to the spindle when the rod is pushed to the right to stop the machine. When the lathe is equipped with the all-geared headstock and the belt drive, power is delivered from a countershaft to a single pulley on the driving shaft of the headstock. The cone headstock lathe is driven in the usual manner from a two-speed countershaft.

Headstock Construction Details

The transmission gears in the headstock are arranged in two groups, the first of which produces the higher speeds of the spindle called, in conehead lathes, the "open-belt speeds," while the second group produces the slower speeds known as the "back-gear speeds." The change from the first to the second group of gears is made by means of the back-gear lever seen at the right-hand end of the headstock beneath the spindle nose in Fig. 3, and the locking lever at the rear. Eight spindle speeds from 13 to 525 revolutions per minute are controlled by the two interlocking levers on the front of the headstock. These levers are equipped with pointers which indicate on an index-plate the speed in revolutions per minute at which the spindle is being driven. The arrangement of the pointers and the index-plate is clearly shown in Fig. 2. All gears in the headstock are made of chrome-vanadium steel, have Maag teeth, and are hardened.

The cone headstock is similar in design to the geared headstock with the exception of the cone being provided instead of the speed gears, and the omission of the speed-change levers. The countershaft supplies two speeds of 125 and 625 revolutions per minute from which sixteen speeds from 9 to 528 revolutions per minute can be supplied to the spindle. A brake lever is provided for conveniently stopping the lathe without applying a hand to the cone. With this headstock can be furnished the Le-Blond belt shifting device.

The geared headstock mechanism is lubricated by the splash method. The lubricant is introduced upon the central gear situated below the center of the spindle, which throws the lubricant in all directions, particularly upward against the cover. The under side of the cover has ribs from which the oil again drips on the mechanism. The

location of the back-gears beneath the spindle makes it a simple matter to lubricate them. The friction clutch and its mating gear are submerged in the lubricant.

Feed-change Gear-box

Changes in speed of the lead-screw or feed-rod are obtained by means of a cone of twelve gears in the feed-box at the front of the bed and a second series of gears which provide thirty-six speeds. In addition, the entire series of thirty-six speeds may be increased by mounting different gears on a sector, as in an ordinary lathe. Each added gear produces another series of thirty-six speeds.

It will be seen in Fig. 2 that there are three horizontal rows of large figures on the index-plate which represent the number of threads per inch which may be cut, and under the large figures there are smaller figures which give the carriage feed per revolution of the headstock spindle, in decimals of an inch for the different settings of the gears in the feed-box. The ratio lever at the left-hand end of the box may be placed in three positions, each of which is directly opposite to one of these rows of figures, and the rocker lever beneath the plate may be located directly under any of the twelve vertical columns of figures. Therefore, after noting on the index-plate the desired number of threads per inch to be cut, the operator is only required to bring the ratio lever opposite the line of figures in which the number of threads appears, and then bring the rocker lever directly beneath the same number. A desired feed per spindle revolution is similarly obtained.

Features of the Carriage

To facilitate threading operations there is a quick-withdrawing device attached to the carriage by means of which it is only necessary to give a quarter turn to a handweel to withdraw the cutting tool quickly from the work. The tool can always be brought back to its initial depth by means of a positive stop. The compound rest must be used with this device; however, the method does not interfere with cutting threads in the ordinary manner. An adjustable ring graduated to half-thousandths of an inch is provided on the cross-feed screw handwheel to regulate the depth of the cut.

In addition to the usual horizontal screw in the tool block, there is an inclined shaft which is connected to the screw by means of bevel gears. A disk graduated similarly to the ring previously mentioned and provided with handles for rotating it is mounted on this shaft. The object of this construction is: (1) To so locate the compound rest feed-wheel and handles that they will never interfere with the regular handwheel of the cross-feed
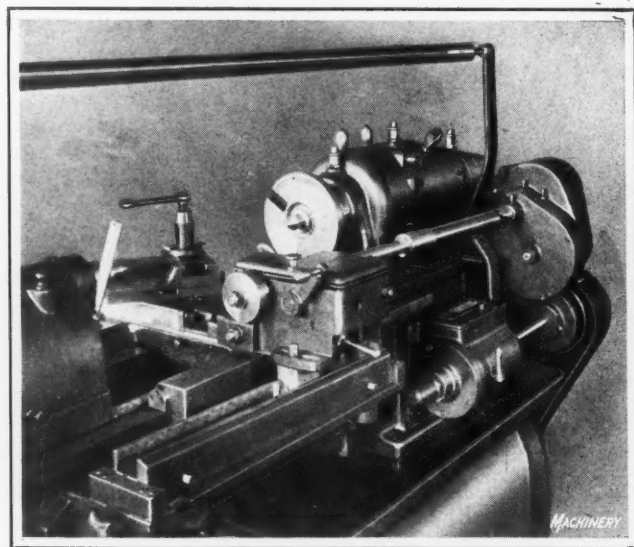

Fig. 5. Arrangement of the Taper and Forming and Relieving Attachments at the Rear of the Bed

screw; and (2) to permit more legible graduations for the compound-rest feed-screw. When tapers greater than the capacity of the taper attachment are to be turned, the work may be done by combining the power longitudinal and cross feeds.

The carriage travel may be stopped or reversed by operating the handle at the right-hand end of the apron. Dogs on the stop-rod provide for automatic control of the carriage movements.

Special Attachments and Equipment

Among the special attachments and equipment which can be furnished for this lathe are included plain, elevating and ball-turning rests, indexing faceplate, taper attachment, external forming and relieving attachment, lathe and drill chucks, and cutting-fluid equipment. A lathe equipped with the taper and relieving attachments is shown in Fig. 5. The taper attachment is fastened to the rear of the bed, but all adjustments are made from the front, which permits the placing of a group of lathes close together in a row.

The external forming and relieving attachment is intended for machining the external surfaces of form cutters and for relieving the teeth after they have been cut. The attachment consists of a bracket fixed to the rear of the lathe carriage and supporting a sliding block temporarily fastened to the toolpost shoe, the nut on the cross-feed screw being detached from the cross-slide. Extending vertically through the sliding block is a guide pin, that contacts with a flat former, the rear edge of which is of the same contour as the cutter to be made. The former is fixed to the taper attachment.

CINCINNATI CENTERLESS GRINDER

Straight cylindrical parts such as piston-pins, roller bearings, king bolts, studs and rods, and shouldered parts such as push-rods, shackle bolts and valve tappets, can be rough-and finish-ground on a centerless grinder that is now being introduced to the trade by the Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio. An idea of the large variety of parts which can be handled may be obtained by referring
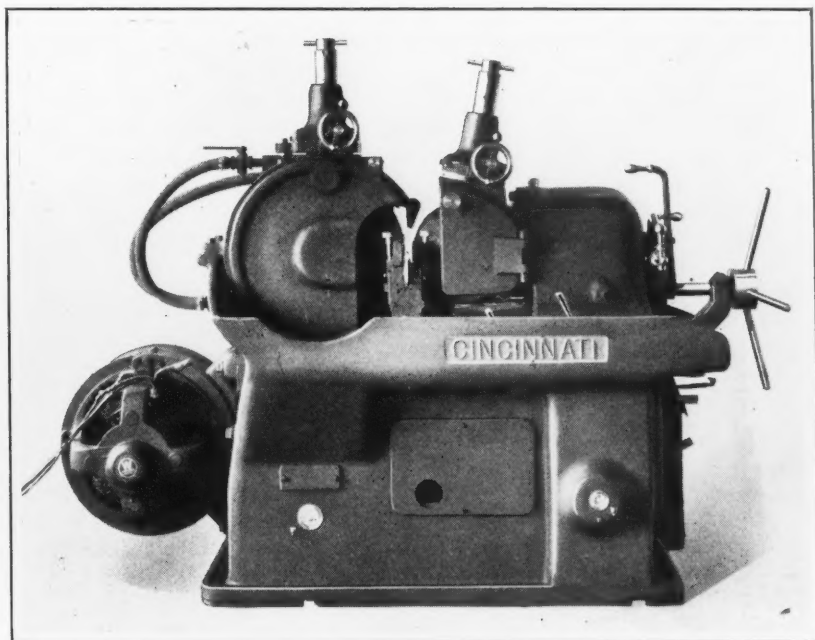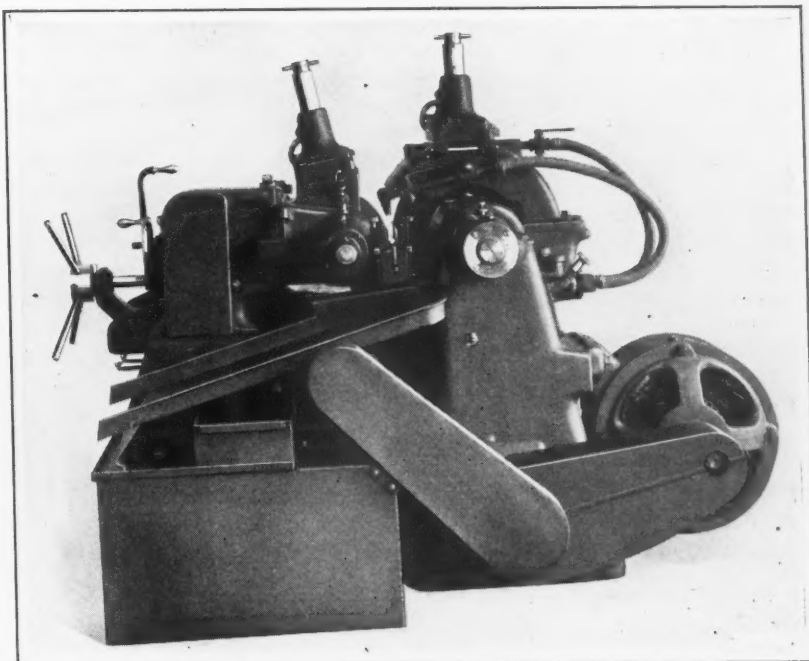
Fig. 2. Rear View of the Cincinnati Centerless Grinder, showing the Motor Drive

to Fig. 5. Plain cylindrical parts are ground by passing them transversely between two opposed abrasive wheels. A grinding wheel 20 inches in diameter is mounted on the left-hand end of the machine and opposing it is a 12-inch wheel. The latter is known as the "feed" or "control" wheel because it controls the rotative speed of the work in traversing between the wheels.

The work is supported in its movement between the wheels by a blade mounted on a work-rest that is placed between the wheels as shown in Fig. 3. The top of this support blade and the grinding-wheel spindle are parallel to each other. The feed or control wheel is carried in a bracket that can be swung about a horizontal axis and clamped in any angular position required by the work being ground. The speed of this wheel determines the speed in revolutions per minute of the work passing through the machine, and the inclination of the wheel determines the feed or lap of the work per revolution. In order to correct an out-of-round piece of work such as a piston-pin, a small feed per revolution, and therefore a small angle of inclination of the control wheel, is desirable; whereas in straightening a crooked pin, a wide lap per revolution, obtained by a wide angle of inclination of the control wheel, is desirable.

Sixteen control-wheel speeds ranging from 16 to 442 revolutions per minute are obtainable through the speed-change box at the right-hand end of the machine. In order to finish a piece of work it is often necessary to pass it between the wheels more than once; the number of passes is determined by the amount of stock to be removed, the condition of the work as to roundness and straightness, the quality of the material, and the specified limits of accuracy. The rest which carries the work-support blade is universal to take care of different diameters of work. Sizing is accomplished by moving the control wheel forward on its slide.

Grinding Shouldered Parts

Work having shoulders is ground by the "straight in" feed method illustrated in Fig. 4, in which a valve tappet is being ground. A 90-degree movement of the lever in the right hand of the operator moves the control-wheel housing either

Fig. 1. Cincinnati Centerless Grinder for Both Straight Cylindrical and Shouldered Parts

forward or backward a distance of 0.030 inch. When the wheel is withdrawn, the piece of work to be ground is laid on the angular support blade and located endwise by means of an adjustable stop. Then, as the lever is brought down, the control wheel is moved forward and the work pushed against the grinding wheel, the desired size being obtained when a full movement has been given to the lever. At the same time that the control wheel is withdrawn by means of the lever, the operator pushes the ejecting knob on which his left hand rests, and the finished piece is pushed forward into a pan. Work having a slight taper can also be ground by this method, it being only necessary to true the grinding wheel to the desired angle.

Construction of the Machine

In the lower part of the frame under the grinding-wheel spindle there is a constant-speed shaft which may be driven either from a lineshaft or from a motor mounted on the bed. A belt connects this shaft to the main grinding-wheel spindle, a swinging idler which can be adjusted from the outside
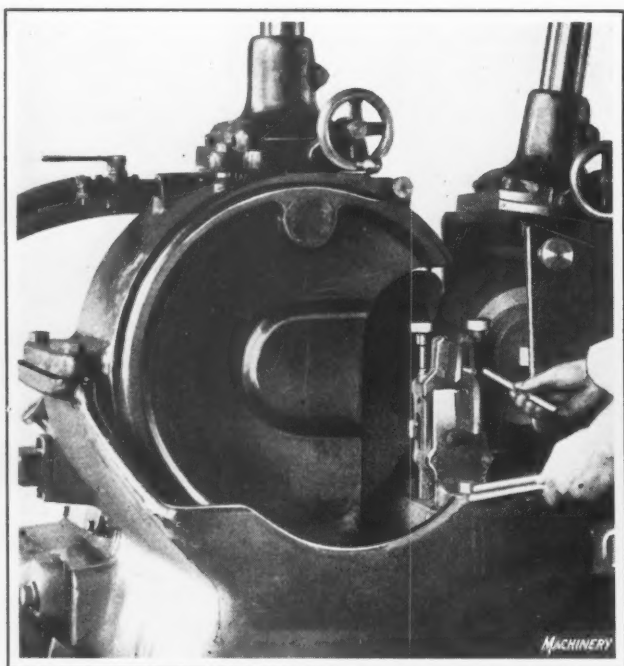
Fig. 3. Method of feeding Plain Cylindrical Work into the Machine

of the machine being provided to keep this belt at the proper tension and to increase the belt contact on the spindle pulley. The drive for the control wheel is taken from this same shaft and transmitted to the speed-change box.

The tilting housing in which the control-wheel spindle is mounted, is gibbed to a sub-slide to which it can be securely locked. This sub-slide also carries the work-rest. Both the control-wheel housing and the sub-slide can be moved forward as a unit or individually by means of the large pilot wheel at the right-hand end of the machine. This independent adjustment of the upper and lower slides makes it possible to obtain set-ups rapidly, which is an important factor where machines are used on jobbing work. The slides are moved forward as a unit to compensate for wheel wear during an operation. A fine adjustment of the slides is obtained by means of an auxiliary crank and a dial reading to 0.0001 inch.

Grinding-wheel Spindle

The grinding-wheel spindle is a heat-treated chrome-nickel steel forging, and is mounted in the main frame of the machine, which is a casting weighing about 4000 pounds. Particular attention is called to an automatic oiling device provided for the spindle bearings which consists of large diameter disk splashers that dip into oil reservoirs and carry the

oil up to collectors in the bearing cap from which it is distributed over the entire bearing. Glass indicators provide a means for observing the operation of the automatic oiling devices at all times. End thrust on the spindle is taken up by a double-row self-aligning ball bearing. It is possible to adjust the spindle while running by means of a knurled thrust collar on the end of the spindle bearing.

Both the grinding and control wheels have 5-inch holes, and wheel collets are supplied for both spindles. Where the grinding wheels are changed frequently, it is recommended that the different wheels be mounted on individual collets to save time in changing and to save the wheels. The machine is so designed that both wheels can be changed easily and quickly; the guards are hinged and the entire front or operating side of the machine may be opened up.

Wheel Truing Devices

One of the features of the machine are the truing devices provided for both the grinding and control wheels. Independent devices are mounted on each wheel guard where

Fig. 4. Manner of operating the Machine in grinding Shouldered Parts

they remain in position ready for use. These truing devices consist of a dovetailed slide hinged at one end to provide for adjustment and supported on the other by an adjusting screw. The diamond is carried in a sleeve mounted in a sliding bracket that is moved across the abrasive wheel by means of the handwheel at the front. This sleeve can be moved up and down in the bracket to accommodate different diameter wheels. A fine adjustment for truing is secured through a screw which is fitted with a micrometer dial.

When setting the control wheel for a new job it should be so trued that the full face bears on the work. To insure this, the angle of inclination of the control-wheel housing and the height of the centerline of the work, above the centerline of the grinding wheel, must be taken into consideration. For any given angle of inclination of the control-wheel housing, the truing fixture is rotated about a vertical trunnion to the same angle, and further, if the proper line of contact between the work and wheel is, for example, ¼ inch above the center line of the grinding wheel, the diamond-holder for the control wheel must be moved ¼ inch off center to the right. The highest control wheel speed, 442 revolutions per minute, should be used in truing.

A centrifugal pump having a capacity of 15 gallons per minute is mounted on a storage tank at the rear of the machine. This pump is driven from the main shaft by a
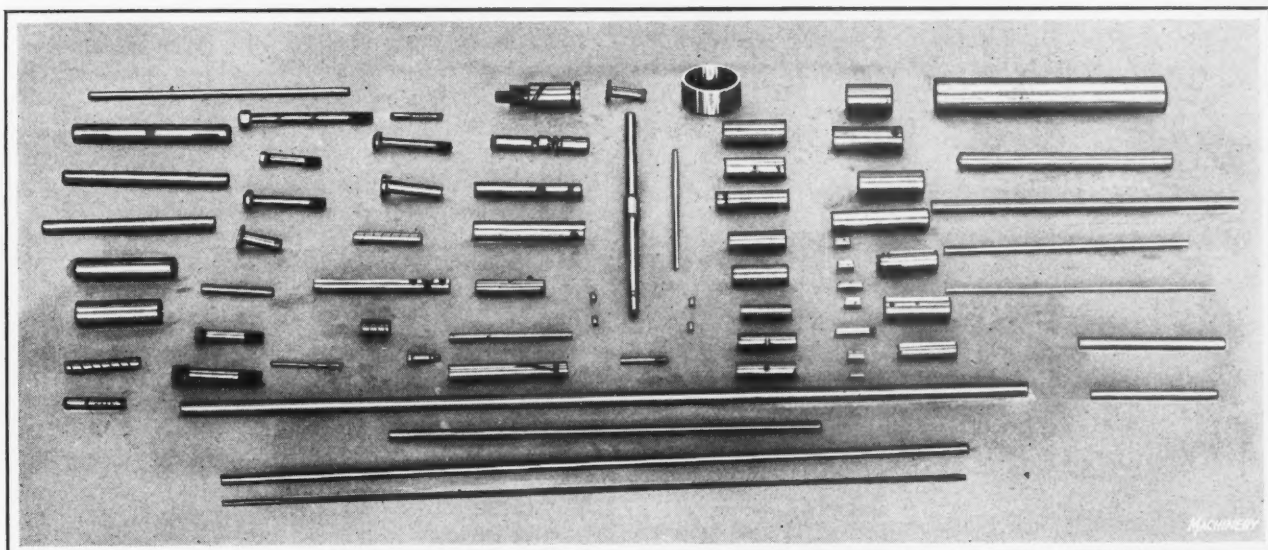
Fig. 5. View showing the Large Variety of Parts that may be rough- or finish-ground on the Cincinnati Centerless Grinder

crossed belt that is easily accessible by removing the guard. The bed of the machine at the grinding wheel end is shaped in such a way that it forms a primary settling basin. The overflow from this basin runs into a secondary settling basin on top of the storage tank and from there into the tank through a cloth bag which removes such grit as comes with the lubricant from the settling basins. The secondary settling basin and the storage tank can be removed for cleaning, and the settling basin in the machine can be drained and cleaned with a shovel.

Wherever possible, an individual motor drive is recommended because the machine is rated at 15 horsepower and hence means a heavy drain on a lineshaft. A constant-speed motor running between 1200 and 1800 revolutions per minute can be used. The weight of this centerless grinder, either belt or motor-driven, is about 5000 pounds.

GARDNER SEMI-AUTOMATIC DISK GRINDING MACHINE

For the semi-automatic grinding of parts which require the finishing of but one flat surface at a time, the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis., is now introducing to the trade the machine here illustrated. The work is automatically presented to the grinding member and so the operator is left free to devote his entire time to loading and unloading the fixtures, which naturally results in greater production. In addition to the advantage of rapid production, an unusual degree of accuracy is claimed for this new design. The grinding member consists of an 18-inch steel disk faced with the Gardner improved abrasive disk when the work is to be ground dry. In cases where

coolant is necessary, the machine is equipped with an 18-inch abrasive ring wheel carried in a "Perfection" chuck.

The parts to be ground are carried to the grinding position in fixtures mounted on an eight-sided revolving drum. The speed at which the drum revolves is variable and may be arranged to suit the amount of stock to be removed, the size of the area ground and the ability of the operator to load and unload the fixtures. The variation in speed is accomplished by means of four change-gears. On each side of the drum there are two T-slots and a straight groove, the latter being intended to receive the tongue usually provided on the bottom of fixtures to insure correct alignment of the work with the grinding member. The drum shaft is of large diameter and the thrust load to which it is subjected is carried by a special self-aligning thrust bearing which bears directly against one end of the shaft.

As the work approaches the grinding position, the grinding disk automatically advances until it reaches a positive stop, contacting with the work under an adjustable spring pressure governed by a cam. Hence the disk advances only as rapidly as stock is removed and there is a constant pressure against the work. The disk is returned to the open position by the action of the same cam. Control of the drum rotation is by means of the foot lever shown at the base of the machine in Fig. 1, this foot lever being employed to operate a double-disk dry clutch at the left-hand end of the machine. To start the drum in motion, the operator depresses the foot lever and to stop the drum, releases it. This arrangement provides an instantaneous control in cases where it is necessary to stop the drum during the loading and unloading.

The grinding head is mounted on a sub-base and is adjustable on this base by means of a hand-wheel which operates through a screw. By
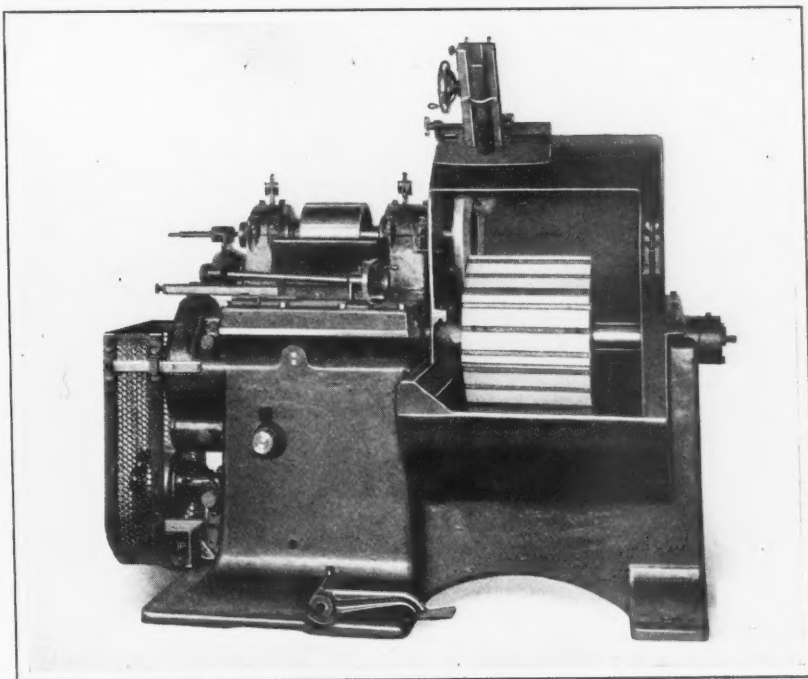
Fig. 1. Gardner Semi-automatic Disk Grinding Machine for Parts ground on One Surface at a Time
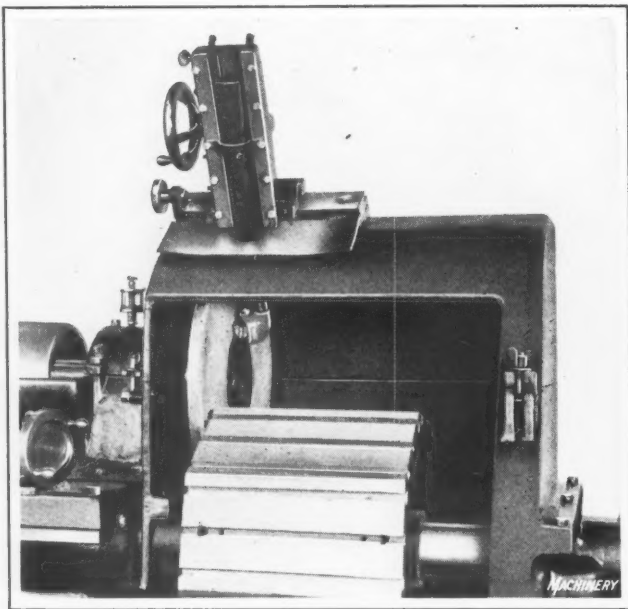
Fig. 2. View showing the Method of applying the Truing Device

the use of a pair of bevel gears and a long shaft, this handwheel is brought within easy reach of the operator. This is a micrometer adjustment, graduation on the handwheel representing movements of 0.005 inch of the grinding head. This arrangement permits a quick and accurate adjustment of the grinding member to compensate for wear. A back plate fills the center of the grinding wheel so that it is impossible for work to fall into the hole in the wheel. This plate is part of a hollow shaft which extends the entire length of the spindle and is so arranged that no adjustment is necessary after the first set-up has been made. In other words, the adjustment of the back plate is entirely separate from the adjustment for wear of the grinding wheel. The hollow shaft is also used to carry the coolant in wet grinding. The cast-iron hood which guards the grinding disk may be connected to an exhaust system to remove all dust and other particles resulting from the operation.

As shown in Fig. 2, the truing device is mounted on a vertical slide attached to the cast-iron hood. Adjustment of the truing device to compensate for wear of the grinding member is obtained by means of a screw. During the truing operation the dresser is traversed in the slide, being actuated by rotating the handwheel. A few of the important specifications of this machine are as follows: Height of spindle from floor, 40 inches; dimensions of faces on drum, 7 inches wide by 14 inches long; production rates obtainable, 16, 23, 38 or 57 pieces per minute; and power required for maximum duty, 10 horsepower.

NESS SPOT-WELDING MACHINE

An electric spot-welding machine designed primarily for operation on alternating current, but which is also adaptable by means of a special device to the use of direct current, has recently been placed on the market by the H. J. Ness Mfg. Co., 305 Broadway, New York City. One of the features of this machine is that the transformer is located within 2 inches of the rear ends of both horns and midway between them. It is claimed that the closer the transformer is to the electrodes, the higher the efficiency of the machine, because the losses of current that occur when low-voltage high-amperage current is conducted any considerable distance are lessened. The electrodes are also heated more uniformly because the lead to each is about the same length. From No. 30 gage wire to ¼-inch rod may be welded on the standard machine with a 10-ampere fuse in the circuit, indicating that the current consumption at no time is more than 10 amperes.

Another feature of the equipment is an oil dash-pot switch which is said to practically eliminate sparking at the switch

points and thus lessen the deterioration of these points, and to make the equipment sensitive by reducing the lag between the switch and the electrodes. The upper horn is carried by a rocking arm lowered on the work by depressing the foot-treadle. The upper electrode comes in contact with the work under spring pressure, the spring being further depressed until the current is turned on. Then the work is heated immediately to the welding temperature, after which the current is automatically turned off. The weld is completed under a spring pressure that is adjustable to suit conditions. Finally, the electrodes are opened and the work released.

Three welding steps are regularly obtainable for each voltage by means of a selector switch, to suit the different thicknesses of material handled. Both 110-volt and 220-volt current may be supplied to the machine, in which case the lower voltage is used for work up to No. 10 wire, and the higher voltage for from No. 9 wire to ¼-inch rod. More steps may be furnished to meet the needs of customers. The 110-volt current is shut off and the 220-volt current turned on by means of a switch. In this three-step switch the only moving part is the knife. In tests made when using the first step in welding No. 15 English gage iron wire, 3.75 amperes were consumed; using the second step in welding No. 14 English gage iron wire, 4.4 amperes; and using the third step in welding No. 10 English gage iron wire, 5.5 amperes.

There are seven adjustments on the machine for regulating the height between the horns, the pressure applied to the electrodes in welding, etc. The treadle position may be shifted 35 degrees to suit the convenience of the operator. The horns consist of cold-drawn copper bars, 2 inches in diameter and are adjustable and water-cooled. The electrodes are secured in them by means of a hand-operated lever and cam lock on each horn. The distance between the horns when closed on the regular machine is 5 inches and on sliding-horn machines 5 inches, minimum, and 16 inches, maximum. The greatest movement of the upper electrode is 2½ inches, and the distance from the floor to the welding points 42 inches. The machine may also be motor driven for automatic operation. The weight of the alternating-current welder is approximately 450 pounds.
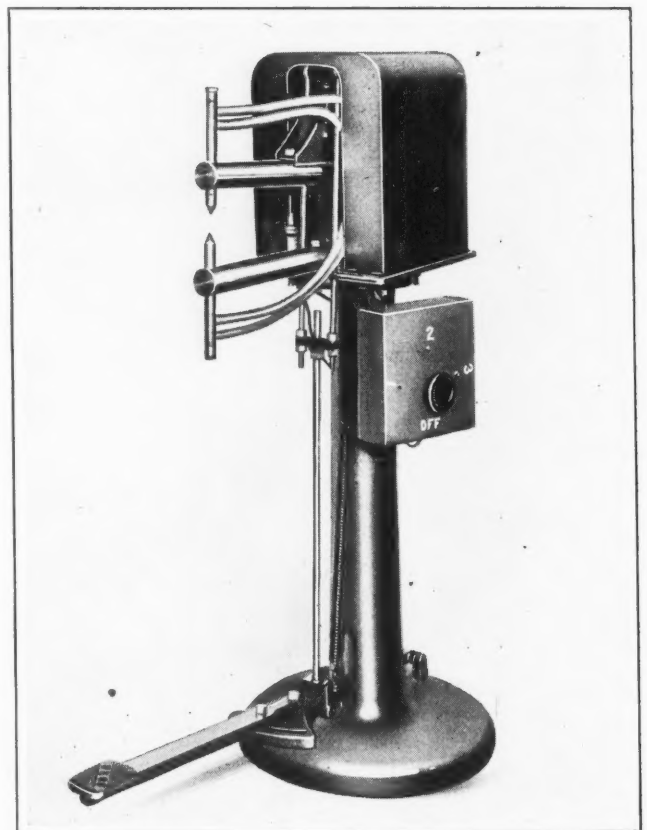
Ness Electric Spot-welding Machine
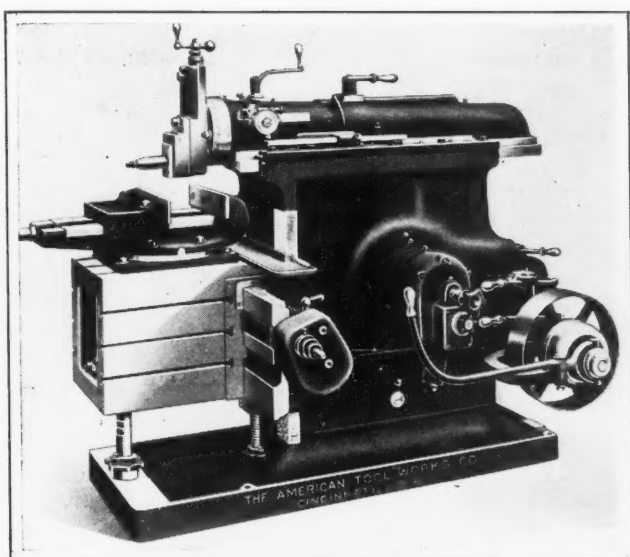
American Heavy-service Shaper with Automatic Cross-feed

AMERICAN AUTOMATIC CROSS-FEED FOR SHAPERS

Fifteen positive feeds ranging from 0.010 to 0.150 inch per ram stroke are now obtainable by means of an automatic mechanism on all heavy-service shapers built by the American Tool Works Co., Cincinnati, Ohio. Each feed is clearly indicated on a graduated dial and can be secured while the machine is in operation by simply turning the feed star-knob until the desired feed, as indicated on the graduated dial, comes opposite a fixed pointer. The feed occurs only on the return stroke of the ram and during the entire stroke, instead of only at the moment of the stroke reversal. It is claimed that this design protects the feed mechanism against shock, increases the life of parts, insures a positive rate of feed and results in a smooth, quiet action.

The feed to the table is under constant control by means of a handle on the rail unit that is always within reach of the operator. With this handle the feed may be engaged in either direction and disengaged by simply throwing the handle to one side or the other or setting it neutral. A positive automatic safety device of new design protects the feed mechanism against damage should the tool gouge the work or the saddle be fed into either end of the rail. One of the features of this safety mechanism is that it requires no adjustment, and it is said to pull the heaviest feeds without slipping.

MINSTER "HI-DUTY" DRILLING MACHINE

To provide for manufacturing operations in which a smaller sized machine can be used to advantage than had previously been built by the Minster Machine Co., Minster, Ohio, this company recently brought out a 1½-inch size which has been designed to meet the requirements of the automotive and other industries where high production is essential. This new machine is built with three different types of drive: (1) It may be furnished with tight and loose pulleys to take power from a lineshaft or from an individual motor; (2) it may be furnished with a single-pulley drive and a single clutch; and (3) where the machine is to be used for tapping, a double clutch is furnished so that power is transmitted through a direct drive for forward rotation of the spindle and through an intermediate gear for backing out the tap. Where either the single or double clutch is provided it is operated by means of a lever A, and on machines equipped with tight and loose pulleys a similarly located lever provides for shifting the belt. In addition to these three types of drive there may be a direct geared drive from a motor.

In order to adapt the machine to the requirements of production work, it is equipped with sliding gears operated by means of lever B, which provide two mechanical speed changes. These changes are supplemented by a pair of pick-off gears enclosed in case C, the gears being supplied in various combinations so that speeds are available over a range of from 73 to 550 revolutions per minute. The pick-off gears are located at the front of the machine where they may be conveniently changed in cases where the machine is set up in batteries, so that there need be very little space between adjacent machines. Another feature is that the gears are located close to the lower end of the spindle thus reducing its torque to a minimum.

Power and hand feeds and a rapid traverse are provided for the spindle. The power feed is obtained by an arrangement similar to that employed for securing speed changes; that is, there are sliding gears operated through push-rod D for obtaining two mechanical changes, and these are supplemented by pick-off gears in case E. By using different pairs of gears, rates of feeds are available from 0.006 to 0.159 inch per spindle revolution. A convenient feature of the pick-off feed-gear case is that the cover is held suspended on the hand-feed shaft when the cover is removed for changing gears. This prevents dropping the cover in making a gear change.

Handwheel F is rotated for feeding the spindle by hand after rod D has been pushed into the neutral position, so as to disengage both power feed gears and permit a worm and wormwheel to be operated by hand. The rapid traverse of the spindle is obtained by means of capstan wheel G which is mounted on a shaft that carries a pinion meshing direct with rack teeth cut in the spindle. By adjusting the position of stop H the power feed may be tripped at any desired point. A special spindle driving-sleeve construction has been developed by means of which it is possible to obtain a spindle movement of from 7 to 15 inches.
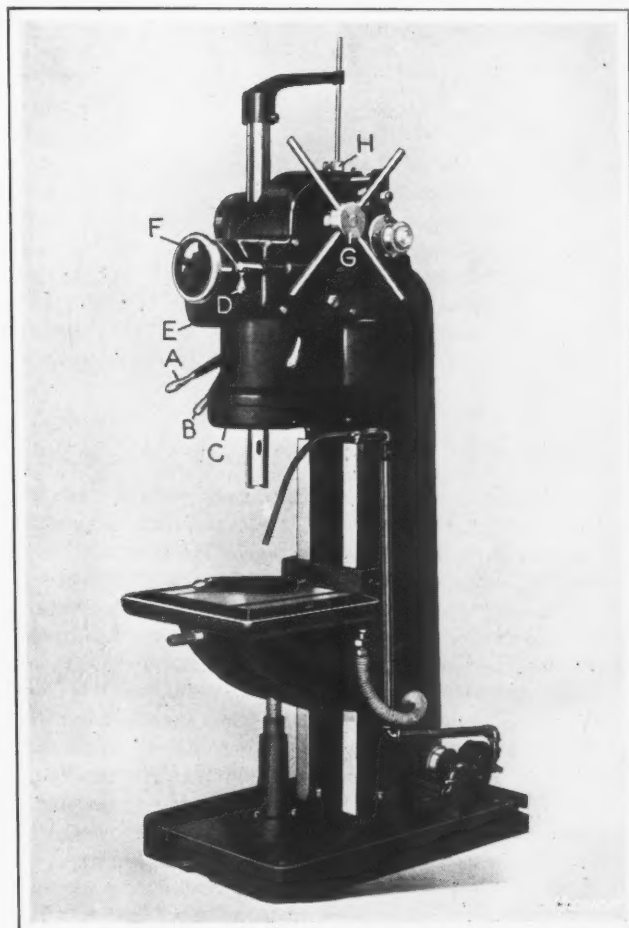
Minster "Hi-duty" Drilling Machine

A special geared pump is incorporated in the machine to deliver oil up through the vertical clutch shaft and discharge it over the gear at the top of the shaft, this gear being the highest point of the mechanism in the head. From this point the oil is thoroughly distributed over all gears and bearings. An oil cup on the side of the head can be opened to ascertain whether the level of the oil supply in the reservoir is correct to assure satisfactory lubrication. In the base of the column there is a reservoir for coolant which is delivered to the tools and work by means of a Trahern pump. There is a means of removing the fluid to flush the tank when cleaning is necessary.

Some of the important specifications of this machine are as follows: Drilling capacity in solid steel, 1½ inches; distance from center of spindle to face of column, 10½ inches; maximum distance from end of spindle to plain table, 30 inches, and to base, 44 inches; vertical adjustment of plain table, 15½ inches; number of feed and speed changes, 4; and approximate weight of machine equipped with plain table, 2065 pounds.

WAYNESBORO NUT-LOCK

A nut-lock which acts on the same principle as the alligator wrench to prevent a nut from backing off a bolt, is now manufactured by the Waynesboro Nut Lock Co., Inc., Waynesboro, Pa. From the accompanying illustration it will be seen that this "Bull Dog" lock has 2 vertical lugs against which sides of the nut contact in being screwed on a bolt. There is also a tooth projecting into the hole of the lock to engage the thread of the bolt.

This tooth does not interfere with tightening the nut, but should the nut be turned to loosen it, the tooth prevents loosening even though a wrench is applied. It is claimed that in a test on a rail joint made up with six bolts equipped alternately with this lock and split spring washers, in which the joint was subjected for over 1½ hours to the blows of a 2000-pound hammer operated at 130 strokes per minute, the nuts held by the spring washers came off, but that those equipped with this lock remained in place. The joint had stretched ½ inch thereby forging the bolts and loosening them.

"Bull Dog" Nut-lock

GREENFIELD IMPROVED SNAP GAGE

In designing the improved snap gage recently brought out by the Greenfield Tap & Die Corporation, Greenfield, Mass., particular attention was given to the construction of the locking device for the anvils. Each anvil is locked in place by means of a flat-head machine screw and a bushing tapped to suit the screw. The bearing of the individual locking bushings is against a flat on the anvils, and so the anvils are held securely and prevented from turning, thus maintaining the alignment of the gaging faces.

In order to insure rigidity, a reinforcing web has been added to the outer edge of the frame. This rib also helps the "feel" of the gage by the hand, particularly so if the hands and gage become slippery due to oil. Provision is made for holding the gage in a stand when this arrangement adds to the convenience of the operation. A feature of the gage is the wide range of adjustment possible for each size. This permits the use of a fewer number of
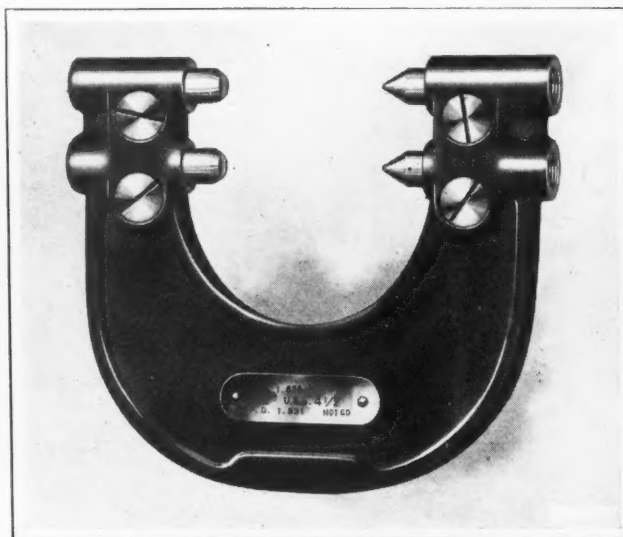
Greenfield Snap Gage of Improved Design

gages to cover a given range of sizes, and means a substantial saving in investment for special work or small production jobs where it is possible to reset the gage from one size to another.

RICKERT-SHAFER AUTOMATIC THREADING MACHINE

A single-purpose machine designed for threading such parts as automobile connecting-rod bolts, steering arms and spark plugs, and electric connectors and pipe plugs, has been developed by the Rickert-Shafer Co., Erie, Pa. The accompanying illustration shows the machine arranged for threading spark plugs. The die-head is carried by a spindle which revolves in two ball bearings and travels to and from the work. The latter movement is obtained through the cylinder cam seen at the left-hand end of the machine as shown in Fig. 1. On this particular machine the work is fed on an eight-station turret which indexes automatically to bring a new piece into position every time that the die-head advances. A close-up view of this turret is shown in Fig. 2. Plugs are threaded at the rate of 28 per minute with this equipment, and an operator can keep two machines loaded. Each piece is automatically ejected after the thread has been cut. The die-head is of the R-S
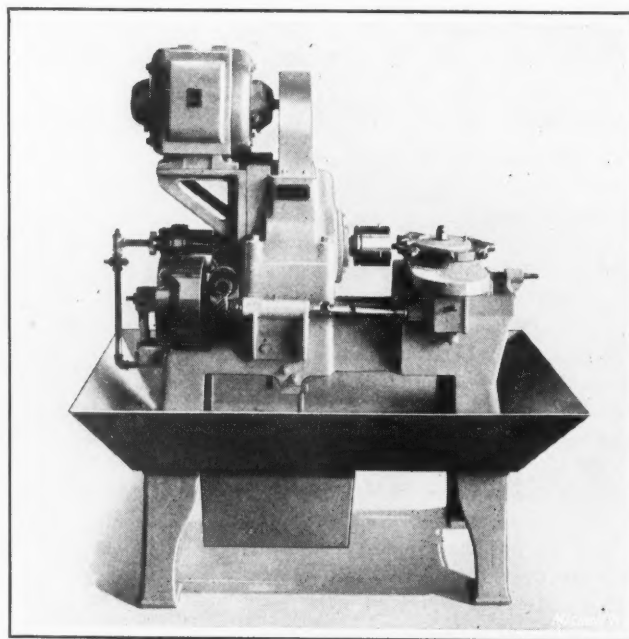
Fig. 1. Rickert-Shafer Automatic Single-purpose Threading Machine

Fig. 2. Eight-station Turret furnished for threading Spark Plugs

revolving type and is opened and closed automatically. Fixtures and cams can be supplied for many threading operations, and the machine can be driven either by a belt from a countershaft or by a silent chain from a motor.

OILGEAR VARIABLE-DELIVERY PUMP

A type W variable-delivery pump designed for use with hydraulic presses and in similar service has been developed by the Oilgear Co., 398 Thirty-eighth St., Milwaukee, Wis. This pump has a maximum capacity of 3060 cubic inches of oil per minute and a maximum working pressure of 1000 pounds per square inch. The amount of oil delivered to the press cylinder is controlled by means of a lever attached to the stroke-changing mechanism through a hydraulically-operated control cylinder. The pump is said to respond instantly and smoothly to the operation of the control handle for either varying the amount of oil delivered or for reversing the direction of delivery. A small gear pump is provided to keep the running parts well lubricated and to operate the control cylinder. The hydraulic control for regulating the stroke of the main pump consists of a double-
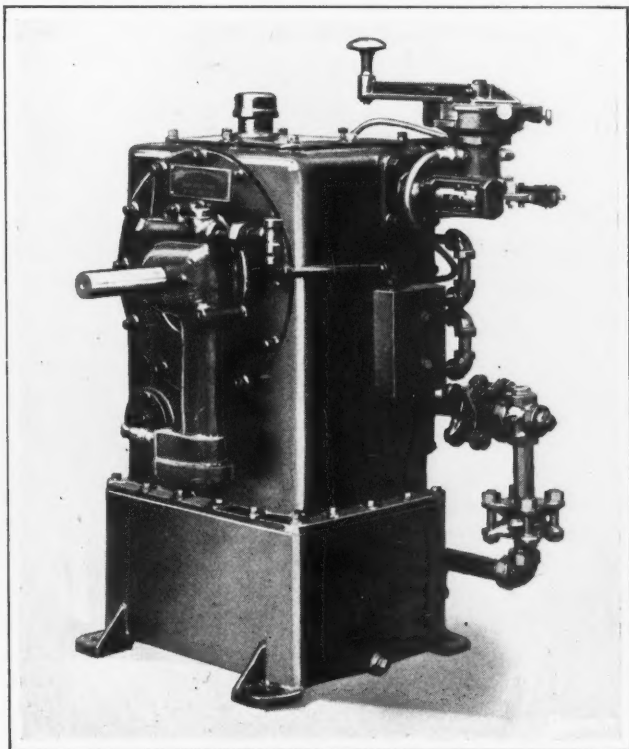
Oilgear Variable-delivery Pump for Use with Hydraulic Presses

acting cylinder and a piston which is attached to the stroke-changing arm by a cross yoke and two links. Oil pressure to the control cylinder is regulated by a small balanced piston valve that admits oil to one end of the cylinder and at the same time allows it to flow from the opposite end. An automatic two-way valve insures the proper direction of the flow of oil to and from the pump.

PETERSEN DOUBLE-ACTION VALVE GRINDER

A double-action grinder for automobile engine valves has been placed on the market by the A. H. Petersen Mfg. Co., Milwaukee, Wis. Through gearing, this grinder automatically combines a revolving and an oscillating motion and thus duplicates the motion of experts when using hand grinding tools for this work. The machine is equipped with an offset attachment which permits easy access to valves located in otherwise inaccessible places. This attachment allows the operator to stand at one side of the engine when grinding any of the valves, instead of sitting over the cylinder block. Three removable driver spindles, 3, 6 and 12 inches long, respectively, are furnished to slip into the chuck. Each spindle will receive any of the driver blades which are supplied to insure proper contact with the different types of valves. The tool makes approximately 275 oscillations and 15

Petersen Automobile-valve Grinder

revolutions per minute. An air-cooled universal motor for alternating or direct current is provided. The length over-all is 12 inches, and the weight about 6 pounds.

RELIANCE INDUCTION MOTORS

A line of type AA squirrel-cage induction motors for 2- or 3-phase alternating current circuits is now manufactured by the Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, Ohio, in various sizes ranging from ½ to 25-horsepower. In designing these motors, special attention was given to the insulation of the stator windings, bearings, rotor construction and overload torque capacity. The coils are wound with cotton covered enamelled wire, and the slot cell insulation consists of special combined press board and oiled muslin. This insulation extends beyond the slot ½ inch at each end. The heads of the coils are covered with cotton tape, half-lapped, this insulation being extended into the slot cell to give added protection to a vital spot.

The bearings are made of phosphor bronze, shouldered in the end bracket and locked against rotation. The bearings can be readily removed from the brackets should replacements be necessary. The rotor is made up of electrical sheets punched to receive the rotor bars which are hard-drawn copper. An end ring of copper is cast on the extensions of the bars to improve this part. It is recommended
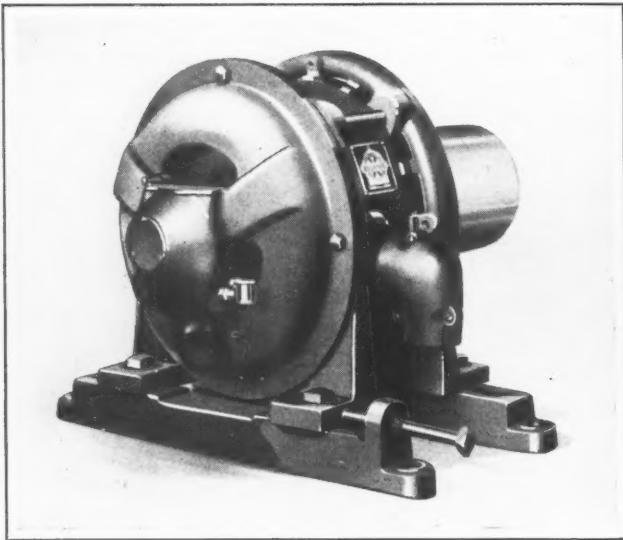
Reliance Induction Motor for Two- or Three-phase Current

that enclosed safety switches be used with motors under 7½ horsepower capacity, or an automatic switch operated by a push-button; but for motors over that capacity, a Cutler-Hammer "auto-transformer" starter is supplied.

BADGER POWER-OPERATED RING-WHEEL GRINDER

A ring-wheel grinding machine equipped with two power-operated tables is now built by the Badger Tool Co., Beloit, Wis. This arrangement of the work-tables makes it possible for one man to tend both ends of the machine. While a piece of work is being ground on one end the operator reloads the fixture at the opposite end. This results in securing a full out-put from the two grinding wheels with one operator and eliminates the labor of feeding-in the work and rocking it back and forth by hand across the face of the grinding wheel.

Truing the wheel is accomplished by means of dressers mounted at the rear of the machine where they do not interfere with operations and are at all times ready for use. Provision is made to align the dresser slides with the machine spindle. Power for rocking the work-tables is transmitted by a belt from a countershaft to a reduction gear-box at the rear of the machine. The rocking motion is imparted to the work-tables by the two straight levers. The work is held against the grinding wheels under an
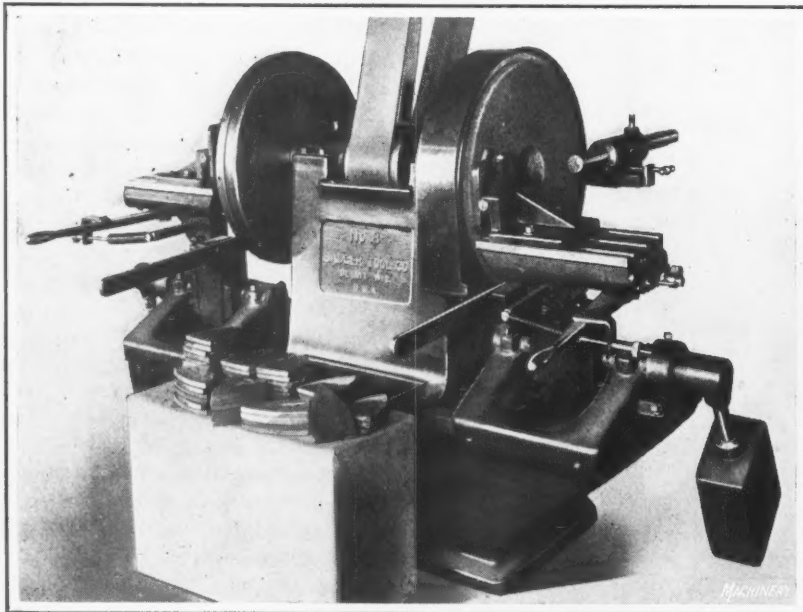
Badger Ring-wheel Grinding Machine equipped with Power-operated Tables

adjustable spring tension through the hand lever on the tables.

On grinding work on either end of this machine the operator disconnects the table rocking lever, grasps the hand lever and draws the table slightly back from the face of the grinding wheel, at the same time rocking the table forward until it clears the wheel. The piece to be ground is then laid in the fixture, after which the operator swings the table back into the grinding position where the table rocking lever engages and then rocks the work slowly back and forth across the face of the wheel. The adjustable spring tension supplies the necessary in-feed. The illustration shows the machine equipped with fixtures for grinding the top and bottom of electric-iron sole plates. The fixtures are of the floating type so as to allow the castings to locate themselves against the face of the wheels in such a way that only a minimum amount of stock need be removed to clean the castings. The two ring-wheels are 24 inches in diameter, and the weight of the machine is approximately 3100 pounds.

YALE ELEVATING-PLATFORM TRUCK

An elevating-platform truck for lifting loaded skids from the floor, transporting them to a given place and raising them for stacking or tiering in store-rooms and other places,
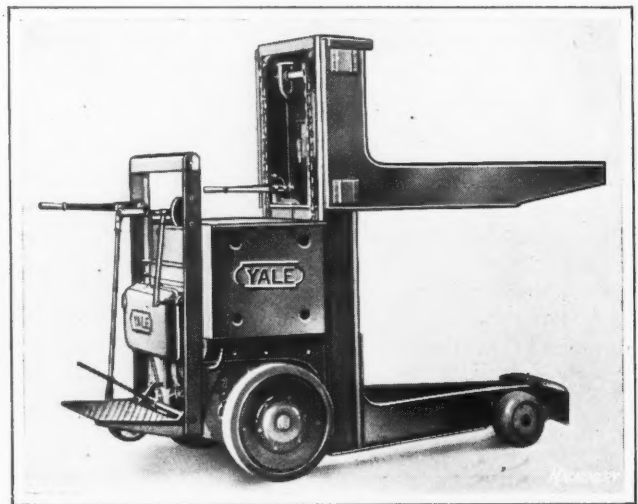
Yale K-22 Elevating-platform Truck

is now being introduced on the market by the Yale & Towne Mfg. Co., Stamford, Conn. The construction of the truck is sufficiently strong to carry loads of 4000 pounds with safety. The lifting and lowering mechanism is of the triple spur-geared reduction type, and is electrically driven. Electric braking, a mechanical auxiliary lowering-speed control, and automatic upper- and lower-limit stops, insure a simple and safe operation. One of the features is the spur-gear unit power axle. This axle, as well as the majority of other parts, units and sub-assemblies, is interchangeable with that of all trucks in the same series. This interchangeability offers operating advantages and economies when two or more trucks of the series are used in one plant. The Yale & Towne Mfg. Co. is also introducing a low-platform truck and a three-wheel tractor truck. The low-platform truck is designed to reduce to a minimum the work of piling heavy loads on the truck either by hand or auxiliary crane equipment. The tractor truck has a low center of gravity which eliminates over-turning or tipping.
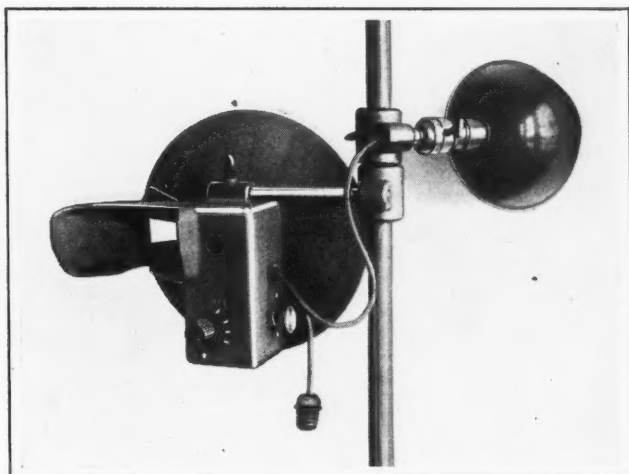
"Rotostat" for observing the Action of Rapidly Moving Parts

"ROTOSTAT"

An instrument known as the "Rotostat" has been brought out by the Rotostat Instrument Co., 600 W. Lehigh Ave., Philadelphia, Pa., for observing the action of rapidly moving parts. The instrument reduces the apparent speed of a part to the point where convenient observation is possible; hence errors in the timing of interlocking parts, unexpected interferences, deformation of parts under centrifugal stresses, instantaneous and periodical speed variations, etc., can be readily studied. Also, erratic motion due to the backlash of gears may be easily detected. After connecting the instrument to an ordinary electric light socket, the two knobs are simply turned until the object appears stationary or moving at the desired speed, when looking through the instrument. The "Rotostat" is mounted on a standard together with a reflector, and both are adjustable on the standard in all directions. No battery or special electric equipment is required.

WILKIE LATHE GRINDING ATTACHMENT

To facilitate the grinding of automobile parts in garages and service stations, the Wilkie Machine Works, Winona, Minnesota, are now manufacturing a motor-driven attachment intended for application to lathes. This equipment is sold in two units; an external grinding unit for finishing pistons, valve seats, spindles, bolts, etc., and a crankshaft grinding unit for use on lathes of 18-inch swing and larger, throw blocks being supplied for this work. The base of the grinding unit is fastened to the carriage of the
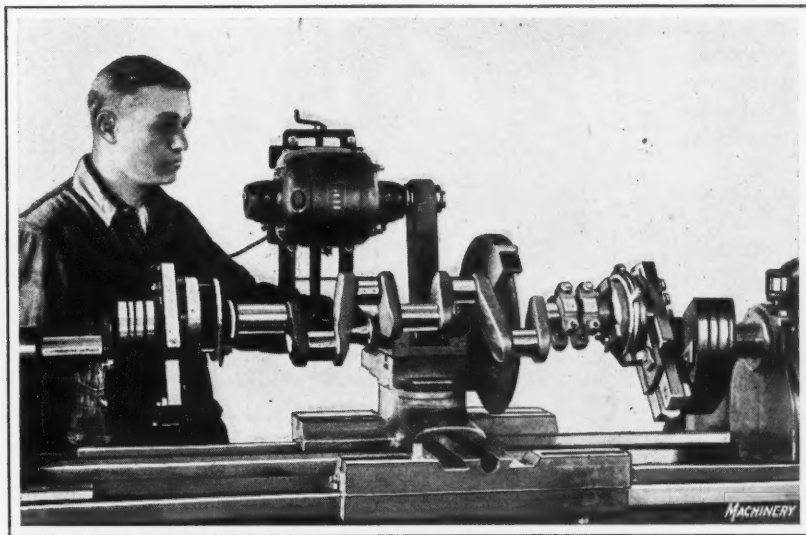
Wilkie Lathe Attachment for Cylindrical and Crankshaft Grinding

lathe by means of a plate machined to fit the slot in the toolpost.

The grinding-wheel spindle is hardened and ground and is located directly above the toolpost slot so that the carriage need not be brought back any farther than for ordinary work. Two grinding wheels, 6 and 10 inches in diameter, respectively, are furnished and these are mounted on locking collets instead of running direct on the spindle. The wheels can be used at either end of the spindle and removed or replaced without taking them off the collets. This eliminates dressing a wheel every time it is set up. The throw blocks used in crankshaft grinding fit the centers of the lathe, as illustrated, for setting the crankshaft off center in grinding the bearings for the connecting-rods. A set of lead counterbalances is furnished for use in this operation. The Zinke Co., 1323 Michigan Ave., Chicago, Ill., is the exclusive selling agent for this equipment.

BLANCHARD DIAL-LOADING AUTOMATIC GRINDING MACHINE

The automatic surface grinding machine recently brought out by the Blanchard Machine Co., 64 State St., Cambridge, Mass., and described in March MACHINERY, was loaded by
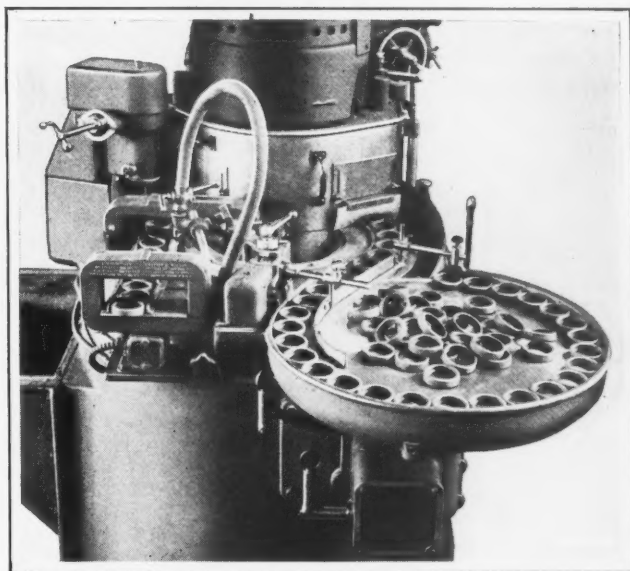
Dial-loading Arrangement furnished on the Blanchard No. 16-A Automatic Grinding Machine

hand, whereas the grinding, maintenance of size, demagnetizing, and chuck cleaning, were entirely automatic. A modified form of this machine has now been developed for grinding rings, washers and similar circular parts. The new machine is known as the No. 16-A automatic grinding machine, dial-loading type. The work is placed on a circular table that rotates at a slightly higher peripheral speed than the magnetic chuck, and automatically feeds the work continuously on the magnetic chuck. A large number of pieces are placed on the loading dial at one time which makes the work of loading intermittent. This relieves the operator for such work as moving containers filled with rough and finished pieces. After placing the work on the dial the entire operation is automatic.

The chuck is non-magnetic at the loading position and so as the work is carried around toward the grinding wheel it is held in place by its own weight. Just before

the work reaches the water guards that enclose the grinding wheel, the chuck becomes magnetized and the piece is then gripped magnetically as it is carried under the water guards and the wheel. The grinding to size is completed in one pass under the wheel, the exact size of the piece being maintained by a caliper which automatically adjusts the wheel-head to compensate for wear of the wheel.

After the work leaves this caliper the chuck again becomes non-magnetic and the work leaves the chuck, passing through the demagnetizer into a container. A washing machine may be added to the equipment so that the parts when discharged will be washed as well as demagnetized. It is said that the machine will maintain sizes to within limits of plus or minus 0.0005 inch and hold work parallel to within 0.0003 inch. In finish-grinding ball-race rings made of hardened steel, 3 5/32 inches in diameter, removing 0.010 inch of stock from both sides, the production rate with the machine is 630 pieces per hour, and in rough-grinding rings made of high carbon steel, 2⅞ inches in diameter, removing 0.020 inch of stock from both sides, the production rate is 650 pieces per hour.

AMERICAN GEAR TESTER

A machine for use in developing, checking and charting involute curves and for testing the spacing of gear teeth, has been brought out by the American Grinder Co., 6534 Benson St., Detroit, Mich. The normal capacity of this ma-
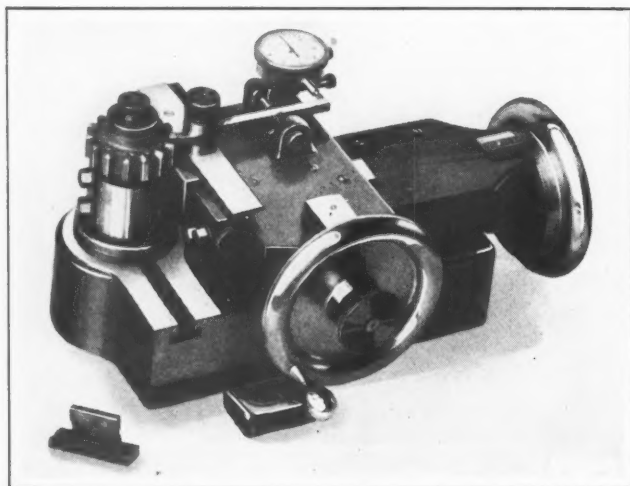
Fig. 1. American Gear Tester for Spur, Helical, and Bevel Gears

chine is for spur, helical, and bevel gears from ½ to 8 inches in diameter, but spur gears up to 12 inches in diameter may be tested. In developing an involute curve for spur gears, an adapter with a base-circle disk and 0.005-inch thick steel tapes is used. The diameter of the adapter is made equal to the diameter of the pitch circle of the gear to be tested times the cosine of the pressure angle. The indicator may be set to read direct or to multiply the readings by 4; it is easy to read to one sixteen-thousandths inch.

In taking readings, the two tapes are tightened, and the top slide and the handwheel, which is friction driven, are set at zero. A gage such as shown at the left in Fig. 1 is used to set the needle at right angles to the slide. The gear is next set on the stud with the needle reading zero which gives a definite starting point at the base circle. If the tooth being tested is a perfect involute curve, the indicator will remain at zero and a chart may be produced by using the handwheel graduations. A plunger automatically retards the handwheel every 0.010 inch. A perfect involute curve will result in a straight line on the chart, while the modified curves result in a concave or convex line.

Ninety-degree spacing of spur-gear teeth is checked by means of the set-up shown in Fig. 1. The indicating needle
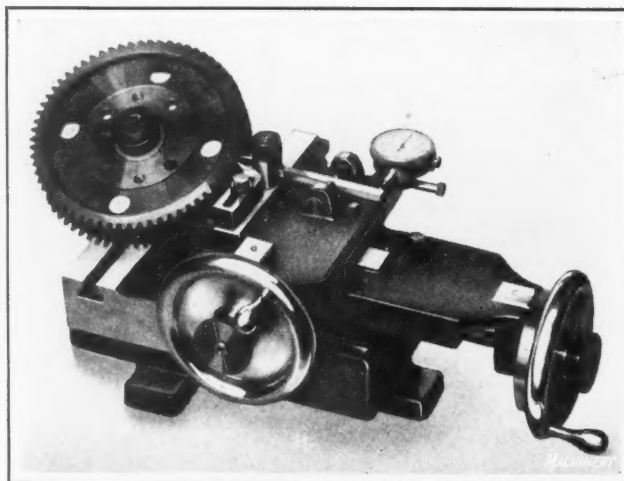

Fig. 2. Set-up of the Gear Tester for inspecting a Helical Gear

may be reversed in cases where it is impossible to reverse the gear. Tooth-to-tooth readings are taken by means of a set-up similar to that shown in Fig. 2 in which a helical gear is being checked. It is sometimes desirable to maintain a master curve or duplicate an established form; this may be done by using the longitudinal slide, first plotting the master and then checking the other curves with the chart. Special adapters are used for checking the spacing and contour of helical and bevel gears.

LAKEWOOD TIER-LIFT TRUCK

The particular feature of a new tier-lift truck recently developed by The Lakewood Engineering Co., Cleveland, Ohio, is its ability to pick up a load without the use of platform skids. This permits the tiering or stacking of units without the waste of the usual 12 or 14 inches incident to skids. It is especially useful in handling such commodities as sheet tin. The truck can pick up loads of from 2000 to 2500 pounds placed on 2- by 2-inch strips. When using these strips it is said that an operator and a helper can unload a 35- or 40-ton car of sheet tin and stack it, say, 125 feet away from the car, in approximately an hour and a quarter. The driving and lifting mechanism is standard, and the forged steel forearms are finished to meet the user's requirements. The truck is built in various lifting heights.
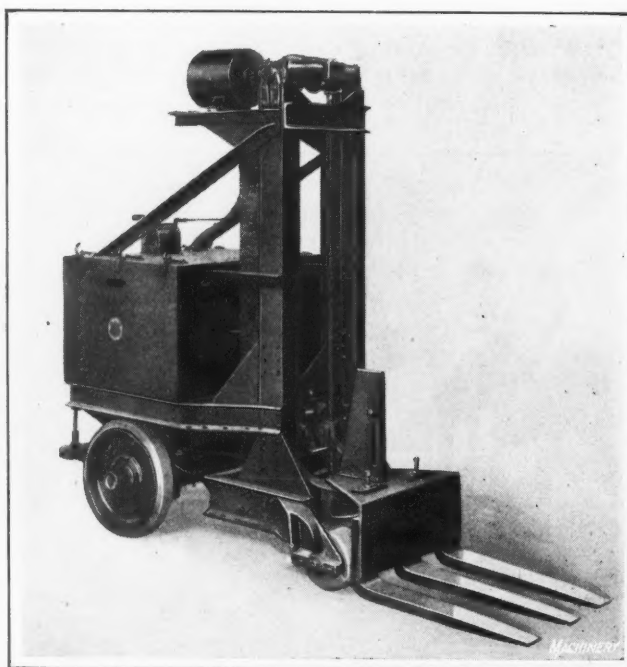
Lakewood Tier-lift Truck for Use without Platform Skids
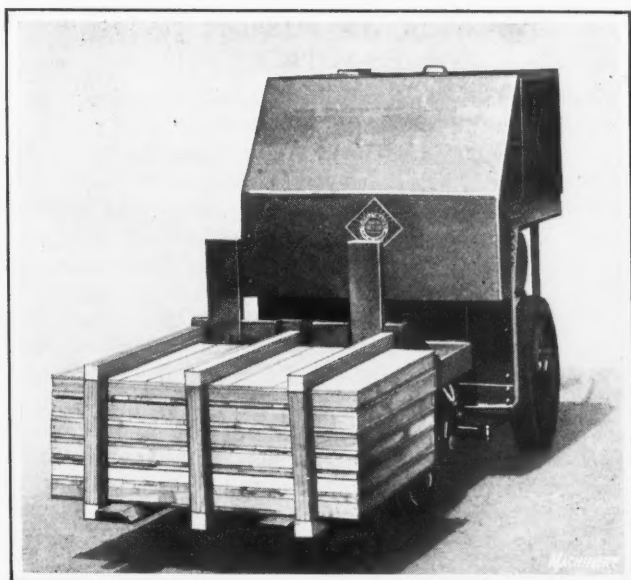
Elwell-Parker Electric Truck equipped with Lifting Arms or Forks

ELWELL-PARKER FORK LIFT TRUCK

A one-man electric truck which provides for carrying the load beyond the front axle, has been placed on the market by the Elwell-Parker Electric Co., Cleveland, Ohio. This truck is equipped with arms or forks so shaped at the outer ends that they may be inserted beneath a casting, box, etc., weighing up to 2500 pounds, for convenient lifting and transportation. The lower side of the forks can be made to touch the floor if necessary or they can be stopped at any height between the upper and lower limits. The length of the forks depends upon the weight carried, since consideration must be given to the loading of the front axle.

The load handled balances an equal weight of the truck in back of the axle and so the pressure imposed on the wheels is relatively great. The front axle is equipped with large roller bearings and 10- by 3-inch tired wheels. These wheels as well as the rear driving wheels are steerable. The raising mechanism consists of a separate motor and a worm-gear reduction and is attached to a movable platen supported on the truck frame by three rocking links. The power or propelling unit consists of a heavy-duty Elwell-Parker motor and controller direct-connected through a flexible coupling to worm-gearing, and a bevel-pinion differential mechanism that runs in oil.
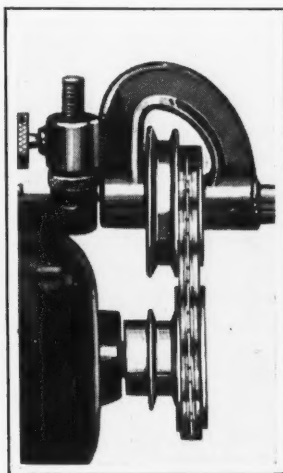
Drive for Haskins Equipments

DRIVE FOR HASKINS EQUIPMENTS

A new type of multiple-speed countershaft is now incorporated in the flexible-shaft equipments manufactured by the R. G. Haskins Co., 520 West Monroe St., Chicago, Ill. One of these equipments was described in MACHINERY, February, 1921. The improvement is said to fill a long-felt want in this class of equipment by providing an easy means of speed variation without sacrificing power on account of friction or belt slippage. The accompanying illustration shows the link-type belt which is now used. This belt is made of leather, metal and fiber and is constructed to run without tension. The belt clings to the special V-pulleys in operation so that there is no slippage.

SYRACUSE OSCILLATING-SPINDLE SANDER

The oscillating-spindle bench sander illustrated, has been placed on the market by the Porter-Cable Machine Co., 1708-12 N. Salina St., Syracuse, N. Y., for use in the pattern shop or woodworking factory that does not have sufficient internal or irregular work to warrant the purchase of the larger machine built for this type of work by the same concern. This machine is equipped with a totally enclosed G. E. motor running at 1725 revolutions per minute and connected direct through the spindle. The latter has an oscillating movement of one inch, and is equipped with ball

Syracuse Oscillating-spindle Sander

bearings and with a roll 2¼ inches diameter by 6 inches long. The table tilts 45 degrees down and 15 degrees up. The dimensions of the machine are 16 by 16 by 25 inches, and the weight 75 pounds. It can also be furnished with a pedestal.
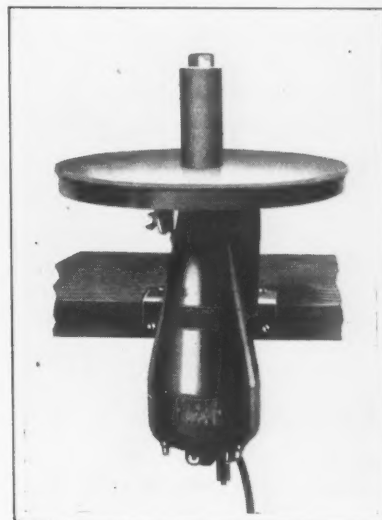
OLIVER WOOD-BORING MACHINE

A No. 72 motor-in-head vertical single-spindle boring machine now built by the Oliver Machinery Co., Grand Rapids, Michigan, is especially suitable for pattern shop use be-
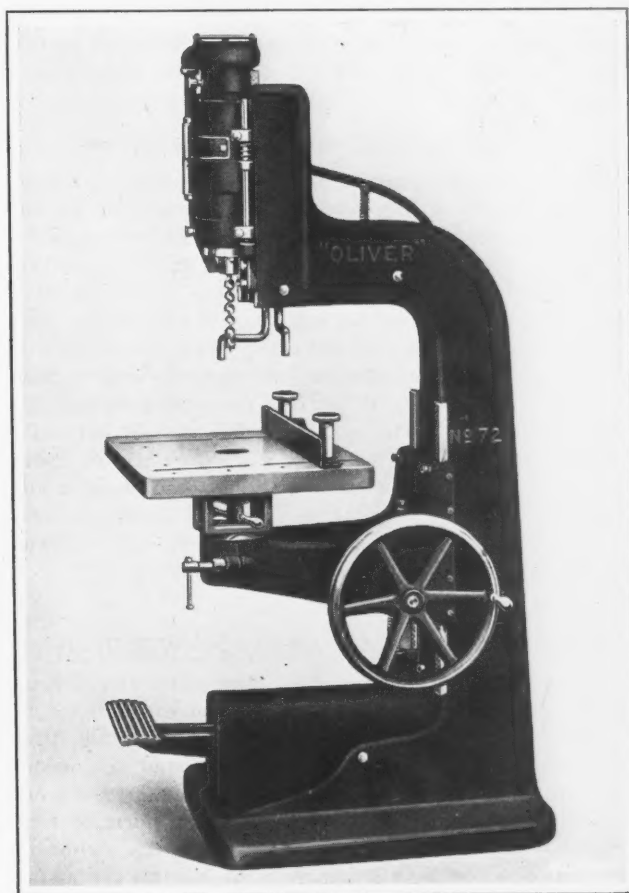
Oliver Vertical Single-spindle Boring Machine

cause of its extra capacity. The distance from the center of the spindle to the column is 18 inches, and permits the handling of large or peculiarly shaped patterns. The table has a vertical movement of 14 inches, may be swiveled about a complete circle and may be tilted up to 45 degrees in any direction. A scale and pointer indicate the angularity of any setting. The entire motor head, with a self-contained blower fan, moves vertically while boring and is driven by a 1½-horsepower motor running at 3600 revolutions per minute with 60-cycle current, and 3000 revolutions per minute with a current of 50 cycles. The combined boring spindle and motor shaft is fitted with ball bearings at each end, and is a piece of high carbon crucible steel, ground to size. At the lower end it is bored to receive ½-inch straight shanks of bits or chucks, and at the upper end it carries the blast fan. This spindle may also be supplied with Morse taper shanks. The table is drilled to receive screws for fastening a wood table to it or forms for special work.

* * * *

NEW MACHINERY AND TOOLS NOTES

Rustless Steel Tape: James Chesterman & Co., Sheffield, England. A rustless steel measuring tape which is hardened and tempered and which is said to possess all the qualities necessary for a high-class tape. Wiebusch & Hilger, Ltd., 106 Lafayette St., New York City, are the United States agents for this tape.

Taper Turning Lathe: Lynd-Farquhar Co., 419 Atlantic Ave., Boston, Mass. A lathe designed especially for turning tapers. The main feature of this machine is an auxiliary bed on which the headstock and tailstock are mounted, while the carriage traverses on the main bed. To turn any taper within the range of the lathe, the clamps of both the headstock and tailstock are loosened and the auxiliary bed is swung out of parallel with the main bed. The live and dead centers remain in line with each other, but they are not parallel with the line of the carriage traverse. Therefore, work is turned to a taper having an included angle equal to twice the amount that the auxiliary bed is set from the carriage line of traverse. The range of this lathe is sufficient for turning any commercial taper.

* * *

CAUSES OF INDUSTRIAL ACCIDENTS

An extensive investigation covering the causes of 350,000 industrial accidents has recently been completed by the National Bureau of Casualty and Surety Underwriters for the National Council on Compensation Insurance. This investigation shows that, in the machine shop industries, machinery is responsible for but 32 per cent of the total cost of accidents; and that in many other industries employing machinery for different processes, the cost of accidents due to machinery is much greater than in the machine shop industry. The industries that showed unusually high percentages of injuries due to machinery are the metal goods, metal toy, button, wooden ware, and wooden toy industries. Woodworking shops—such as furniture, and sash, door, and blind manufacturing shops—also showed high percentages of injuries from this cause.

* * *

WELDING ROD FOR CAST-IRON WELDING

When electric arc welding first came into use, difficulties were experienced in obtaining a homogeneous weld in cast iron. The welds often would be so hard that they were difficult to machine. It has been found that monel metal furnishes an excellent welding material for cast iron, and such metal is now on the market in the form of rods or wires intended for this purpose. Locomotive cylinders have been repaired by welding with the electric arc and a monel metal wire, and have been machined on the inside after welding without difficulty.

NEW BOOK ON TURRET LATHE PRACTICE

Turret Lathe Practice. By Erik Oberg. 307 pages, 6 by 9 inches; 319 illustrations. Published by The Industrial Press, 140-148 Lafayette St., New York City. Price, $3.

Between the simple hand-manipulated engine lathe and the fully automatic machine, there is a large field of application for turret lathes. While engine lathes are applicable to an endless variety of work without requiring special and expensive tools, they are not generally applied to quantity production of duplicate parts. On the other hand, automatic machines capable of performing rapidly a given cycle of operations are used only when the number of duplicate pieces is large enough to warrant the expense of rather elaborate tooling equipment, set-ups and adjustments. The turret lathe is simpler and more easily adjusted than an automatic, and more suitable to quantity production than the engine lathe, because all the tools needed for a given series of operations can be readily and successively placed in the working position. The production of duplicate parts efficiently and accurately on turret lathes depends very largely on the tooling equipment and its arrangement, and the best method of determining how to use turret lathes is by studying approved practice as applied to both typical and special operations.

In this treatise the methods of setting up and using turret lathes are shown by presenting a large variety of typical operations, all of which have been obtained from well-equipped manufacturing plants. These examples, which include both chuck and bar work, show what types of tools are used for external and internal surfaces, the relative positions of tools giving the best results under different conditions, and means for chucking or holding work, and for insuring the required degree of accuracy. The operations vary from those representing typical or standard turret lathe practice, to work requiring special tool equipment; and the variety of operations presented in this volume will be of benefit, not only to students of modern practice in machine-building plants, and to tool designers and others directly engaged in tool equipment work, but to shop executives as well.

* * *

INDUSTRIAL EXPANSION IN TEN YEARS

The survey of current business, prepared by the Department of Commerce, Washington, D. C., gives some interesting figures on the increase in production that has taken place in many industries in the United States during the past ten years. The production of pig iron in May, 1923, was 51 per cent above the average monthly production in 1913. May, of course, was the record month, but the average production for the first five months in 1923 was 34 per cent above the average production in 1913. Similar increases in production are found right along the line. The production of steel ingots averages 55 per cent over the production in 1913, and the freight handled in net ton miles in April this year was 40 per cent and in March, 44 per cent in excess of the monthly average in 1913. As these figures are based on tonnage and not on prices, they form an accurate comparison of the increase in the volume of production and business.

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BRITISH STANDARD STEEL SECTIONS

The British Engineering Standards Association has recently issued tables giving the moments of inertia and other properties of the new British standard steel sections. The report is entitled "Dimensions and Properties of British Standard Rolled Steel Sections for Structural Purposes" and may be obtained from the offices of the British Engineering Standards Association, 28 Victoria St., S. W. 1, London, England, at the price of 1s. 3d.

STANDARDS FOR TAPPER TAPS AND NUT TAPS

By C. M. POND, Assistant Manager, Small Tool Works, Pratt & Whitney Co., Hartford, Conn.

The accompanying tables give dimensions for tapper taps and nut taps that have recently been adopted as standard by the leading tap manufacturers. In determining the diameter of the shank for tapper taps, the following rules are used: For sizes from ¼ to ½ inch, the diameter of the shank equals the U. S. S. basic root diameter. For sizes from 9/16 to 1 inch, the diameter of the shank equals the U. S. S. basic root diameter minus 0.004 inch. For sizes from 1⅛ to 2 inches, the diameter of the shank equals U. S. S. basic root diameter minus 0.006 inch. The limits on the shank are as follows: For ¼ to ½ inch; maximum, size given in table; minimum, size given minus 0.005 inch. For diameters from 9/16 to 1 inch: maximum, size given in table; minimum, size given minus 0.006 inch. For diameters from 1⅛ inch to 2 inches: maximum, size given in table; minimum, size minus 0.008 inch.

For the nut taps, the rule for the shank diameter and tolerances on shank and square are given in separate tables, as indicated. The size of the square equals the diameter of the shank times 0.75.

* * *

INTERNATIONAL CONFERENCE ON STANDARDIZATION

At the conference of the secretaries of national industrial standardization bodies held in Zurich, Switzerland, last July, thirteen countries were represented, including all the important industrial nations of Europe and America. One of the most important topics discussed by the conference was the interchange of information between the various national bodies during the development of standardization work. At a conference held in London two years ago, arrangements were made for the systematic interchange of completed work, but experience has shown that it is extremely important also to exchange information relating to work in progress.

At the conference in Switzerland a plan was laid for the preparation of a vocabulary containing technical terms of importance in standardization work. This vocabulary of technical terms will be prepared in the first place in English, French, and German, but will be supplemented, as far as feasible and necessary, by the corresponding terms in other languages. The countries represented at the conference were Austria, Belgium, Canada, Czecho-Slovakia, France, Germany, Great Britain, Holland, Italy, Norway, Sweden, Switzerland, and the United States.

* * *

GERMAN MACHINE TOOL EXPORTS

Statistics recently published by the Department of Commerce show that Germany exported in 1913 about 90,000 tons of machine tools, as against 78,000 tons in 1922. The imports amounted to 7500 tons in 1913, as against 1600 tons in 1922. In every class of machinery, except locomotives, the exports from Germany in 1913 were greater than in 1922. Locomotives alone show higher figures for 1922, due largely to the business done with Russia and Southeastern Europe.

STANDARD DIMENSIONS OF TAPPER TAPS

Diam. of Tap, Inches	No. of Threads Per Inch		Diameter of Shank, Inches	Length of Thread, Inches		Length Overall, Inches
	U.S.S.	S.A.E.		U.S.S.	S.A.E.	
¼	20	28	0.185	1⅝	1¼	12 & 15
5/16	18	24	0.240	1¹³⁄₁₆	1⅜	12 & 15
⅜	16	24	0.294	2	1½	12 & 15
7/16	14	20	0.345	2¼	1¹¹⁄₁₆	12 & 15
½	13	20	0.400	2¼	1¹¹⁄₁₆	12 & 15
9/16	12	18	0.450	2½	1⅞	12 & 15
⅝	11	18	0.503	2½	1⅞	12 & 15
11/16	11	16	0.565	2½	1⅞	12 & 15
¾	10	16	0.616	2¾	2	12 & 15
13/16	10	...	0.679	2¾	...	12 & 15
⅞	9	14, 18	0.727	3	2	12 & 15
15/16	9	...	0.789	3	...	12 & 15
1	8	14	0.834	3½	2⅝	12 & 15
1⅛	7	12	0.933	3½	2⅝	15
1¼	7	12	1.058	3½	2⅝	15
1⅜	6	12	1.153	4	3	15
1½	6	12	1.278	4	3	15
1⅝	5½	...	1.383	4	...	15
1¾	5	...	1.484	4½	...	15
1⅞	5	...	1.609	4½	...	15
2	4½	...	1.705	4½	...	15

STANDARD DIMENSIONS OF NUT TAPS

Diam. of Tap, Inches	No. of Threads Per Inch		Diam. of Shank, Inches	Size of Square, Inches	Length of Thread, Inches		Length Overall, Inches
	U.S.F.	S.A.E.			U.S.S.	S.A.E.	
3/16	24, 32	...	0.133	0.100	1⅜	*1	4½
¼	20	28	0.185	0.139	1⅝	1¼	5
5/16	18	24	0.240	0.180	1¹³⁄₁₆	1⅜	5½
⅜	16	24	0.294	0.220	2	1½	6
7/16	14	20	0.345	0.259	2⅜	1¾	6½
½	13	20	0.400	0.300	2½	1⅞	7
9/16	12	18	0.450	0.337	2¾	2	7½
⅝	11	18	0.503	0.377	3	2¼	8
11/16	11	16	0.565	0.424	3	2¼	8½
¾	10	16	0.616	0.462	3¼	2½	9
13/16	10	...	0.679	0.509	3¼	...	9½
⅞	9	14, 18	0.727	0.545	3⅝	2¾	10
15/16	9	...	0.789	0.592	3⅝	...	10½
1	8	14	0.834	0.625	4	3	11
1⅛	7	12	0.933	0.700	4¾	3½	11½
1¼	7	12	1.058	0.793	4¾	3½	12
1⅜	6	12	1.153	0.865	5⅜	4	12½
1½	6	12	1.278	0.958	5⅜	4	13
1⅝	5½	...	1.383	1.037	5½	...	13½
1¾	5	...	1.484	1.113	5½	...	14
1⅞	5	...	1.609	1.207	5½	...	14½
2	4½	...	1.705	1.279	6⅛	...	15
2⅛	4½	...	1.828	1.371	6⅛	...	15½
2¼	4½	...	1.953	1.465	6⅛	...	16
2⅜	4	...	2.042	1.531	6⅞	...	16½
2½	4	...	2.167	1.625	6⅞	...	17

*For 32 threads per inch, U. S. F.

TOLERANCES ON SHANK DIAMETER AND SQUARE OF NUT TAPS

Diam. of Tap, Inches	Shank	Square*
3/16–½	Size to size minus 0.005"	Size to size minus 0.004"
9/16–1	Size to size minus 0.006"	Size to size minus 0.006"
1⅛–2	Size to size minus 0.008"	Size to size minus 0.008"
2⅛–2½	Size to size minus 0.010"	Size to size minus 0.010"

*Size of square = diameter of shank × 0.75

DIAMETER OF SHANK OF NUT TAPS

Diam. of Tap, Inches	Diameter of Shank
3/16–½	U. S. S. Basic Root Diam.
9/16–1	U. S. S. Basic Root Diam. minus 0.004"
1⅛–2	U. S. S. Basic Root Diam. minus 0.006"
2⅛–2½	U. S. S. Basic Root Diam. minus 0.008"

OBITUARIES

EDWARD MILTON WOODWARD

Edward Milton Woodward, president and treasurer of the Woodward & Powell Planer Co., Worcester, Mass., died at his home in Worcester, August 3, aged seventy-seven years. Mr. Woodward was born in Marlboro, N. H., November 11, 1846. He attended the public schools of Marlboro, and completed his studies at the New Hampton Literary Institution in New Hampshire. Later he learned the machinist's trade with his uncle, Charles Buss of Marlboro, who manufactured woodworking machinery. After completing his apprenticeship he went to Worcester, where he entered the employ of Lathe & Morse as a journeyman machinist. He left Worcester in 1870, and went to Baltimore, Md., where he served as a mechanical expert at the southern headquarters of the Weed Sewing Machine Co. for ten years. In 1880 he resigned and became a salesman with E. P. Bullard, making New York City his headquarters for seven years. During that period he was admitted to partnership w i t h Mr. Bullard, which partnership was dissolved in 1887, when Mr. Woodward located again in Worcester, and soon afterward organized the Powell Planer Co., later incorporated as the Woodward & Powell Planer Co.
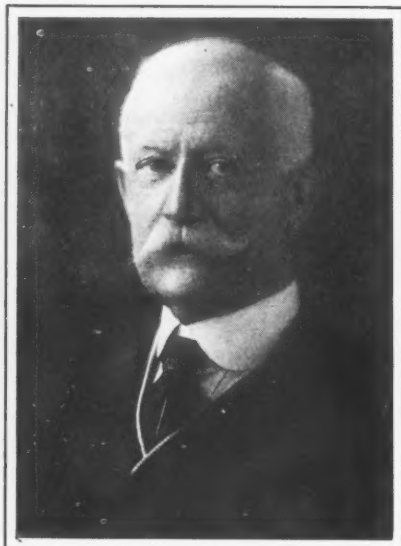
Mr. Woodward was the third president of the National Machine Tool Builders' Association. He was also at one time president of the Worcester branch of the National Metal Trades Association, the Worcester County Mechanics' Association, and the Worcester Chamber of Commerce. These honors indicate the high regard in which Mr. Woodward was held by his contemporaries in business and mechanical circles. In 1897 he served as president of the Board of Aldermen in Worcester, and held several other offices of trust in the community's service. He gave freely of his time, energy, and ability to public interests.

Mr. Woodward is survived by one son, Edward Milton Woodward, Jr., who is vice-president of the Woodward & Powell Planer Co.

ALPHONSE H. GITS, of the Gits Bros. Mfg. Co., Chicago, Ill., died at Estes Park, Col., August 7, in an airplane accident while on his vacation. Mr. Gits was born at West End, Belgium, in 1881. He left school at the age of fourteen, and received his early mechanical training in his father's blacksmith shop, where he remained for three years, afterward working as a journeyman in different machine shops. At the age of twenty-two he came to Chicago, and was employed in the experimental department of the Western Electric Co., where he made several valuable inventions. In 1921 the Gits Bros. Mfg. Co., now located at S. Kilbourne Ave, Chicago, started in the oil-cup business with a small capital, and a floor space of about 1500 square feet. The business has been unusually successful, and today occupies 40,000 square feet in a factory owned by the firm.

R. L. MEIXELL, secretary since 1916 of the Coats Machine Tool Co., Inc., New York City, died July 6.

LONG LIFE OF ELECTRIC MOTORS

Electric motors have unusually long life when given reasonable care. In the shop of the Southern Pacific Railroad, at Sacramento, Cal., there is a Westinghouse motor still in service that has been running for twenty-seven consecutive years, having been installed in 1896. The motor is known as a Westinghouse Tesla type B alternating-current induction motor, and is of 15 horsepower, 1200 revolutions per minute, three-phase, 60 cycles, 500 volts.

PERSONALS

B. B. QUILLEN, president and general manager of the Cincinnati Planer Co., Cincinnati, Ohio, has just returned from a six weeks' trip to Alaska.

H. L. ERLICHER, formerly assistant to the general purchasing agent of the General Electric Co., Schenectady, N. Y., was made assistant general purchasing agent on August 1.

C. F. FREEMAN, of the Surface Combustion Co., has been transferred from the position of manager of the Pittsburg district to that of chief engineer. His address is now 366 Gerard Ave., New York City.

JOHN F. CUNNINGHAM, JR., has been appointed assistant manager of the Production Department of the Schenectady Works of the General Electric Co. He has served the company in various capacities since 1901.

EUGENE L. BEISEL, formerly with the Reeve-Fritts Co., Chicago, has become associated with Charles H. Besly & Co., of Chicago, and will represent that company in the states of New York and Pennsylvania. Mr. Beisel will have headquarters at 79 Norwalk Ave., Buffalo, N. Y.

EDWARD T. OLIVER, who formerly represented the Victor Tool Co., Waynesboro, Pa., as general salesman, has become associated with the Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturer of twist drills and reamers. Mr. Oliver will represent this company in the Ohio territory, and his headquarters will be in Cleveland.

PROFESSOR ROBERT H. SMITH, in charge of the machine shop department of the Massachusetts Institute of Technology, Cambridge, Mass., has recently been awarded the honorary degree of Master of Science by the Rhode Island State College. Professor Smith has been connected with the Massachusetts Institute of Technology for many years, and is the author of two well-known text-books on machine shop work.

GRAHAM BRIGHT, formerly general engineer in charge of the coal and metal mining activities of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has joined the firm of Howard N. Eavenson and Associates, mining engineers, of Pittsburg, Pa. Mr. Bright will give special attention to power house systems, power plant appraisals, transportation and transmission systems for coal and metal mines, and general industrial power applications.

J. P. MOSES of Joseph T. Ryerson & Son, Inc., Chicago, Ill., has been appointed general manager of railroad sales, with offices in Chicago. He succeeds H. A. GRAY, who has resigned to enter another field of business. Mr. Moses has been with the firm for over twenty-two years, and is well known in railway circles. For years he has specialized in high-grade refined iron, known as "Ulster Special," which is used largely by the railroads for staybolt purposes.

MAJOR R. W. CHANDLER, manager of the truck division of the Yale & Towne Mfg. Co., Stamford, Conn., sailed on the *Vollendam* of the Holland-American Line, Saturday, July 28, for an extended business trip to England, France, Belgium, Holland, Sweden, Norway, and Denmark. The immediate reason for this trip is that the new line of electric storage battery industrial trucks just put out by the company has awakened a great deal of interest in European manufacturing centers.

THOMAS T. RICHARDS, since 1919 sales manager of the Wagner Electric Corporation, St. Louis, Mo., has been elected vice-president and manager of sales of the company. Mr. Richards was born in St. Louis, Mo., in 1871. He took an engineering course at the Washington University, St. Louis, and has been connected with the Emerson Electrical Mfg. Co., the Westinghouse Electric & Mfg. Co., and the Minneapolis Gas Light Co. Since 1905 he has been with the Wagner Electric Mfg. Co.

H. T. BRADLEY has been appointed manager of eastern railroad sales of Joseph T. Ryerson & Son, Inc., Chicago, Ill., with offices in New York City. Mr. Bradley became associated with the company in 1906 and spent a great deal of his time as a sales engineer in the machinery department. For the last seven years he has been connected with the railroad division as assistant manager. He has concentrated his efforts largely on staybolt iron and special railroad machinery in the eastern territory.
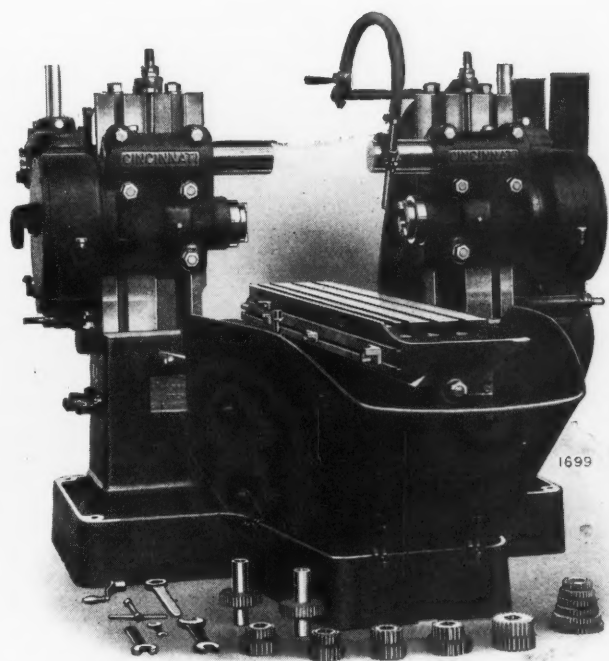
DR. THOMAS ADDISON, often called the father of the electrical industry in the West, has retired at his own request as Pacific Coast manager of the General Electric Co., Schenectady, N. Y., and will be succeeded by J. A. CRANSTON, formerly northwestern manager. Dr. Addison has been with the company for thirty-three years, and has held his present position since 1892. When the western branch of the company was reorganized in 1890, he was selected to go to San Francisco as local manager. Two years later he became Pacific Coast manager of the General Electric Co., and this post he has filled for more than thirty years.

TRADE NOTES

NEIL & SMITH ELECTRIC TOOL CO., Cincinnati, Ohio, manufacturer of portable electric drills and grinders, has moved from 815 Broadway to new quarters at 905-907 Broadway, Cincinnati.

EDWIN HARRINGTON, SON & CO., INC., Philadelphia, Pa., manufacturers of machine tools and chain hoists, announce that beginning July 31 the name of the concern was changed to The Harrington Co.

ACME NEWARK MACHINE WORKS, INC., is now located at 115-117 Monroe St., Newark, N. J., where, in larger premises, additional equipment has been installed to handle an increasing volume of business.

MORRIS TOOL CO., INC., manufacturer of production tools and tool-holders, whose offices were formerly located at 30 Church St., New York City, has removed its offices to the company's factory at 22 Thames St., New York City.

OILGEAR CO., Milwaukee, Wis., manufacturer of hydraulic presses, broaching machines, variable delivery pumps, and variable-speed drives, has moved its office and factory into larger quarters at 398-406 Thirty-eighth St., Milwaukee.

ELLIOTT & STEPHENS MACHINERY CO., 901-904 Chemical Bldg., St. Louis, Mo., dealer in machine tools, announces that this company is now exclusive distributor in the St. Louis territory for the Lodge & Shipley Machine Tool Co.'s line of lathes.

UNION MFG. CO., New Britain, Conn., manufacturer of lathe, drill, and planer chucks, has been notified by the Bureau of Awards of the Brazilian Centennial Exposition at Rio de Janeiro, that the company has been awarded a gold medal for the chucks exhibited at the exposition.

AMERICAN HIGH SPEED CHAIN CO., Indianapolis, Ind., manufacturer of silent chain, has removed from 401 S. Illinois St., to the corner of South St. and S. Delaware Ave., where the company will have 5000 square feet of floor space on one floor, making possible a greatly increased production.

OILGEAR CO., 398-406 Thirty-eighth St., Milwaukee, Wis., has appointed the E. A. Kinsey Co., 235 S. Meridian St., Indianapolis, Ind., selling agent for Oilgear products (including broaching machines, hydraulic presses, variable delivery pumps and variable-speed drives), in the states of Indiana, Kentucky, and Tennessee.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis., manufacturer of excavators, cranes and machine tools, has appointed the Laughlin Barney Machinery Co., Pittsburg, Pa., representative and sales agent in western Pennsylvania and eastern Ohio, for the company's complete line of horizontal boring, drilling, and milling machines.

SURFACE COMBUSTION CO., 362 Gerard Ave., Bronx, New York City, manufacturer of industrial furnaces, has appointed F. J. Winder manager of the Pittsburg district, with offices at 927 Union Arcade Bldg., Pittsburg, Pa. A. J. Huston has been placed in charge of the Buffalo district with headquarters at 45 Andrews Bldg., Buffalo, N. Y.

UEHLING INSTRUMENT CO., 473 Getty Ave., Paterson, N. J., manufacturer of steam power plant economy apparatus, including CO_2 recorders, has appointed the following new southern representatives: Connor-Hudson Co., Southwestern Life Bldg., Dallas, Tex.; Gibbons & Gordon, Inc., 532 Canal St., New Orleans, La.; and the Cornell Mathews Co., 10 Oak St., Orlando, Fla.

MAX AMS MACHINE CO., 101 Park Ave., New York City, manufacturer of automatic can-making machinery and sheet-metal working machinery, presses and dies, has placed its Chicago offices at 20 E. Jackson Blvd., in charge of M. D. Hopkins, who for a number of years has represented the Angelus Sanitary Can Machine Co., of Los Angeles in the Middle Western territory.

DRIVER-HARRIS CO., Harrison, N. J., states that the fire that recently destroyed the Newark Ball Club Park in the vicinity of the manufacturing buildings at the Driver-Harris Co. did not cause any damage to the company's buildings, and that the report to that effect is incorrect. The trade in general, therefore, is informed that deliveries are not being held up due to this cause.

E. C. ATKINS & CO., Indianapolis, Ind., manufacturers of saws and power hacksaw machinery, announce that John P. O'Connor has been appointed manager of the company's branch at Seattle, Wash. Mr. O'Connor has been connected with E. C. Atkins & Co. at Seattle for a great many years, and is therefore well known among saw users and buyers in the state of Washington. He succeeds C. E. Hurlbert who recently died.

INTERNATIONAL MACHINE TOOL CO., Indianapolis, Ind., manufacturer of the Libby turret lathe, has purchased the patterns, jigs, and fixtures of the Milwaukee shaper, formerly built by the Milwaukee Shaper Co., Milwaukee, Wis.,

and will continue to manufacture this line of shapers for the market. It is planned to make shapers in five sizes, from 9½ to 32 inches. The company is planning to make deliveries early in November.

WM. GAERTNER & CO., 5445-5449 Lake Park Ave., Chicago, Ill., manufacturers of scientific instruments, who for over twenty-five years have been located at the above address, have just begun building a new modern factory and office building at the southwest corner of Wrightwood and Racine Aves. The new building, which will be 154 by 135 feet, and will cost about $150,000, will be equipped in the most modern way for the production of scientific instruments, including astronomical telescopes.

POLLARD BROS., Chicago, Ill., manufacturers of shop benches, bench legs, and other shop equipment, formerly located at 3670 Milwaukee Ave., moved into larger quarters September 1, at 4034-4036 N. Tripp Ave. The firm has just added to its line of factory equipment a complete line of factory stools. An electrically operated hoist for raising an automobile from 1 inch to 6 feet, so that a mechanic working on a car can stand erect under it, has also been added to the line of products manufactured by the firm.

UNITED STATES ELECTRICAL TOOL CO., Cincinnati, Ohio, manufacturer of portable electrically driven drills and grinders, has moved its Detroit district office from the Marquette Bldg., to 50 E. Canfield Ave., and its Columbus office from 430 N. High St., to 509 N. Park Ave. At both of these new locations a large stock of tools will be carried to insure prompt shipment of orders. A well equipped service station, with a complete stock of parts for all tools built by the company, will also be maintained. The changes made will place these two district offices on a par with the other eleven offices that are maintained in the larger cities in the United States.

SURPLUS STEEL & IRON SERVICE, 327 S. La Salle St., Chicago, Ill., is the name of a new company that has just been formed to act in the capacity of purchasing and sales agent for surplus steel and iron, as well as for factory and automobile supplies. The object of the company is to serve as a link between manufacturing concerns having surplus material in store-rooms, and possible buyers who might be glad to obtain quick deliveries of just the kind of stock that is not needed in the present owner's hands. All the transactions will be conducted by the company as agent only, as no material will be purchased for resale, a commission being charged only on sales actually made through the company's efforts. F. X. Devlin is general manager.

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POWER AND MECHANICAL ENGINEERING EXPOSITION

The second annual exposition of power and mechanical engineering held at the Grand Central Palace, New York, will take place during the week beginning December 3. This exposition last year drew an attendance of 47,600 representative engineers, operating men, executives and technical students. The entire first floor of the Grand Central Palace has already been engaged by exhibitors for the second annual exposition. The dates for the exposition will bring it in parallel with the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. The technical sessions of the American Society of Mechanical Engineers will be held in the mornings, and as the exposition does not open until noon each day, there will be no conflict between the meetings of the society and the exposition. The exposition is conducted under the auspices of the National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City.
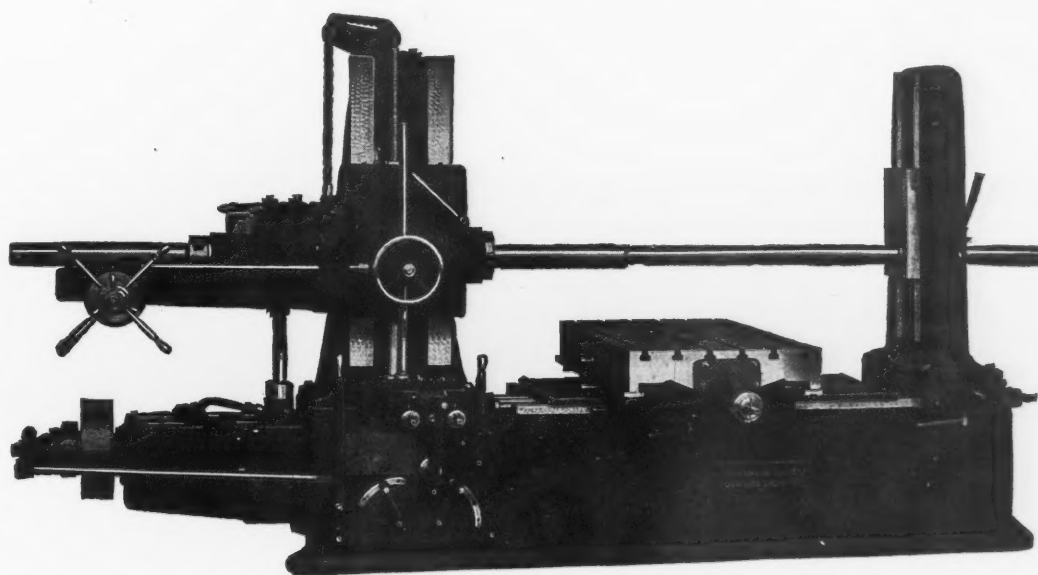
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COLLEGE PROFESSORS KEEPING STEP WITH PRACTICAL ADVANCE

A large number of professors and instructors of engineering schools have been spending five weeks of their summer vacation studying electrical equipment production at the East Pittsburg and South Philadelphia works of the Westinghouse Electric & Mfg. Co. In this way these men are able to come in close contact with the latest production methods and to obtain a broader viewpoint of industry in general, so that they may be better fitted for teaching engineering subjects. Each professor and instructor specializes in some particular activity of his own choice—either design, application, production, or testing. Each day the group has a daily conference with one of the department heads of the Westinghouse company. This conference program is of a broad scope, and brings the teachers in contact with specialists on all phases of electrical, steam, and auxiliary equipment.
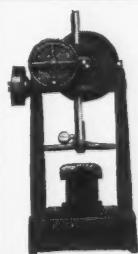
COMING EVENTS

September 17-22—Ninth national exposition of chemical industries, in the Grand Central Palace, New York City. For further information address National Exposition of Chemical Industries, Grand Central Palace, New York.

September 18-21—Third annual machine tool exhibit given by the New Haven branch of the American Society of Mechanical Engineers in the Mason Laboratory, New Haven, Conn. Chairman of exhibition committee, A. C. Jewett, 400 Temple St., New Haven.

September 24-28—Meeting of the Association of Iron and Steel Electrical Engineers at Buffalo, N. Y., in conjunction with the Iron and Steel Exposition held in the Buffalo Auditorium. Further information may be obtained from the Association of Iron and Steel Electrical Engineers, Empire Building, Pittsburg, Pa.

October 8-12—Annual convention of the American Society for Steel Treating to be held in Pittsburg, Pa., in connection with an international steel exposition. W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio, national secretary.

October 25-26—Production meeting of the Society of Automotive Engineers at Cleveland, Ohio. Further information may be obtained from the society's headquarters, 29 W. 39th St., New York.

October 29-31—Convention of the American Management Association in New York City; headquarters, Hotel Astor. Further information can be obtained from the secretary of the association at 20 Vesey St., New York City.

NEW BOOKS AND PAMPHLETS

Formulas and Tables for the Calculation of the Inductance of Coils of Polygonal Form. By Frederick W. Grover. 26 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 468 of the Bureau of Standards. Price, 10 cents.

Engineering Kinematics. By William Griswold Smith. 282 pages, 6 by 9 inches; 341 illustrations. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $3.
This book treats of the fundamental principles of motion—its laws, conversion, and transfer—and the applications of these principles to the design of the innumerable agencies for transmission, transportation and production. Throughout the book the material is closely related to actual engineering problems and conditions. Problems are presented at the close of each chapter illustrating the principles described. In most cases a typical example with complete information is given first, and this is followed by one with blank spaces for data to be supplied by the teacher. The nine chapters are headed as follows: Definitions and Fundamentals; Determination of Relative Velocities and Accelerations of Simple Linkwork Parts; Chains of Linkwork; Direct Contact Pairs, Rolling Curves, Friction Transmission; Toothed Gearings for Parallel Shafts; Gears on Non-parallel Shafting; Cams; Belt, Rope, and Chain Transmission; and Trains of Mechanism.

NEW CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, N. Y. Bulletin 43976, entitled "Charging Equipment for Vehicle Motive-power Batteries."

Westinghouse Union Battery Co., Swissvale, Pa. Storage battery data sheets, giving dimensions and capacities of various types of batteries made by the company.

Magnus Electric Co., Inc., Greenwich and Desbrosses Sts., New York City. Radio catalogue and reference book, containing forty pages of information concerning radio products.

Uehling Instrument Co., 473 Getty Ave., Paterson, N. J. Bulletin 117, illustrating in diagrammatic form the simple principle of operation of Uehling CO_2 recording and indicating equipment.

Hobart Bros. Co., Troy, Ohio. Folder describing the new HB eight-hour constant potential charging method, and illustrating the new HB 200 ampere charger equipped with non-reversing voltage regulating winding.

United States Drill Head Co., Cincinnati, Ohio. Circular illustrating and describing fixed-center multiple drill heads—single-purpose tools for rapid-production drilling—and patented adjustable multiple-spindle drill heads.

Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating and describing Ingersoll open-side milling and boring machines for general production work, as well as Ingersoll open-side tool-room milling and boring machine.

Superior Die Casting Co., Cleveland, Ohio. Circular of "Super Cast" aluminum, white brass, lead and tin die-castings showing illustrations of a wide variety of parts which can be produced economically by the "Super Cast" process of die-casting.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Catalogue illustrating a large number of installations of the Shepard electric "Liftabout" hoist, classified according to industries. Indexes of some of the materials handled and the industries using the "Liftabout" hoist are included.

U. S. Ball Bearing Mfg. Co., 4527-4567 Palmer St., Chicago, Ill. Revised price list of Strom ball bearings, covering single- and double-row radial bearings, adapter type radial bearings, angular contact bearings, and thrust bearings. In all, twenty-seven different types of ball bearings are listed.

Adolph Muehlmatt, Cincinnati, Ohio. Catalogue of sensitive drilling machines, illustrating and describing the machines built by Adolph Muehlmatt, and showing in considerable detail the constructional features of these machines, for which sensitiveness and accuracy are the principal claims.

Pawling & Harnischfeger Co., Milwaukee, Wis. Bulletin 305, covering the company's complete line of traveling grab bucket cranes and monorail hoists. The bulletin has thirty-two pages, and contains illustrations of various kinds of grab bucket equipment as well as views showing applications in many industries.

Wiesman Mfg. Co., Beaver Bldg., corner of 4th and St. Clair Sts., Dayton, Ohio. Circular illustrating and describing the Wiesman safety guard, which automatically sweeps the operator's hands safely aside before the downward stroke of the press, thereby avoiding all danger. This safety guard is of very simple yet effective construction.

New Departure Mfg. Co., Bristol, Conn. Bulletin 70 FE, showing the application of ball bearings to a portable electric screw-driving machine; 71 FE, application of ball bearings to a screw-type water pump; 155 FE, ball-bearing wheel-head for cutter grinder; 156 FE, ball-bearing friction drive assembly of industrial locomotive.

A. P. Munning & Co., Matawan, N. J. Catalogue of 275 pages illustrating and describing electroplating and buffing apparatus and supplies. In addition to listing a very full line of equipment and supplies used by platers and polishers, the catalogue also contains much information on chemical and electrical subjects of value to electroplaters.

Thomas Elevator Co., 28 S. Hoyne Ave. and Monroe St., Chicago, Ill. Catalogue entitled "The Barker Wrenchless Principle," illustrating and describing in detail the Barker wrenchless chucks made by the company, and calling attention to the origin and development of this chuck. The catalogue also illustrates and describes the Barker drill press vise.

Charles Bond Co., 617-619 Arch St., Philadelphia, Pa. Booklet F, illustrating and describing Grundy patent flexible insulated couplings and Mather patent flexible couplings. The booklet describes these couplings in detail, points out their applications, and explains the advantages obtained through their use. Tables of dimensions are also included.

Henry Prentiss & Co., 149 Broadway, New York City. Circular descriptive of the automatic sensitive drilling machines made by the Avey Drilling Machine Co., and sold by Henry Prentiss & Co. This circular also contains a list of used machine tools carried in stock by the latter company including all the standard machine tools and some special machines.

Hall Planetary Thread Milling Machine Co., Inc., Philadelphia, Pa. Circular illustrating and describing the planetary method of external and internal thread milling, and also illustrating the Hall planetary thread milling machine, which is made in semi-automatic and automatic types with single and multiple heads, for cutting straight or taper threads.

Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, Ohio. Bulletin 5018, describing a new line of alternating-current motors known as Type A-A Reliance induction motors for two- and three-phase alternating-current circuits. The bulletin completely illustrates and describes this new type of motor, and gives a table of ratings and general outline dimensions.

Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. Folder illustrating and describing the "Safety First" belt stick made by the company. The folder also calls attention to the Ready Tool Co.'s other products, including toolholders, lathe tools, threading tools, cutting-off tools, lathe dogs, milling machine dogs, grinder dogs, high-speed centers, boring-bars, and vise hold-downs.

Athol Machine & Foundry Co., Athol, Mass. Catalogue 36B of Athol vises. The catalogue illustrates and describes the different types of vises made by the company, including vises intended for garages, plumbers, woodworkers, jewelers, and machinists. Combination pipe vises, drill press vises, milling machine vises, and pipe grips are also illustrated and described, as well as the company's line of bench grinders and grindstones.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. Booklet entitled "Besly Titan Abrasive Disks," illustrating and describing abrasive disks used in connection with disk grinders, that are so constructed as to insure fast cutting and long life. Numerous illustrations from practice are included in the booklet, as well as reproductions of letters from users of Besly abrasive disks. Methods of truing and setting up the disk are thoroughly described and carefully illustrated.

Pratt & Whitney Co., Hartford, Conn. Catalogue 11, of small tools and gages, containing 494 pages, 5 by 7¼ inches. This catalogue covers the entire line of small tools made by the company—taps, dies, screw plates, milling cutters, reamers, punches, drills, and miscellaneous tools, including taper pins, lathe mandrels, ratchets, and threading tools, knurling tools, cutting-off tools, hand chasers, hollow mills, counterbores, forming tools, and screw pitch gages.

Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Catalogue 5, illustrating and describing the Hanna line of pneumatic and hydraulic riveters, made in sizes ranging from 4-inch to 21-foot reach, and in capacities from 10 to 150 tons. The catalogue describes the design and action of the Hanna riveters in detail, illustrating the method of operation with clear line engravings. Photographs are also included of several types of riveters, and complete installations in customers' shops are shown.

R. G. Haskins Co., 516-520 W. Monroe St., Chicago, Ill. Catalogue of flexible shaft equipment and portable tools. This catalogue contains illustrations, with complete descriptions, of the various types of flexible shafts and portable tools manufactured by the company, and includes numerous illustrations showing the actual application of the company's tools in practice, as, for example, in die and tool work, light high-speed grinding, die-sinking, automobile repair shop practice, patternmaking, drilling, and numerous other applications.

Fellows Gear Shaper Co., Springfield, Vt. Booklet entitled "The Thread Generator," describing a new application of the gear-shaper cutter and a rapid-production machine for accurately generating thread shapes, such as those used on taps, worms and other threaded parts. The booklet contains a complete treatise on the subject, divided into two chapters; the first of which deals with the theory of thread generation on the new machine developed by the Fellows Gear Shaper Co., and the second with the machine on which this process is performed.

Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn. Booklet entitled "The New Forbes Pipe Cutting and Threading Machine," illustrating and describing the new and improved pipe cutting and threading machines built by the company. The booklet contains a brief historical review of the development of pipe cutting and threading machines, describing, in this connection, the first Forbes machine designed in 1882. Actual examples are shown of the use of pipe cutting and threading machines in practice, the examples being taken from many industries.

Diamond Chain & Mfg. Co., Indianapolis, Ind. Booklet entitled "Tables, Charts, and Formulas," containing considerable information of value to engineers and designers in selecting chains, sprockets, and sprocket cutters. The booklet presents some entirely new charts and information on the design and application of roller chain drives, and a complete description of the new standard sprocket tooth form approved by the American Society of Mechanical Engineers and by the leading manufacturers of roller transmission chains. Tables showing horsepower, working loads and speeds, useful data on sprocket proportions, and simple rules and formulas for the design of chain drives are also included.

Norton Co., Worcester, Mass. Booklet entitled "Factors Affecting Grinding Wheel Selection," containing a discussion of the selection of grinding wheels for different kinds of work. One of the valuable features of the book is a table listing the abrasives and process to be employed on a wide variety of grinding operations. The table gives two columns of wheels to be used, the first one, headed "First Selection," listing the wheels that should be tried first, and the second giving the usual range of wheels that are suitable for use under ordinary operating conditions. Booklet entitled "Electric Furnaces for the Laboratory," describing the construction of different furnaces for laboratory work.

Niles-Bement-Pond Co., 111 Broadway, New York City. Publication entitled "Modern Facilities for Miscellaneous Locomotive Repairs." This is the fifth of a special series of railroad numbers of the Niles-Bement-Pond "Progress Reporter." The publication contains complete lay-outs for central railroad repair shops for taking care of 750, 500, and 300 locomotives, respectively. A list of complete equipment is included, as well as illustrations from railroad repair shops showing different types of equipment in use. The preceding publications dealing with railroad work are as follows: No. 29, "Roundhouse Running Repair Facilities"; No. 30, "Smith and Hammer Shops, Foundry and Pattern Shops for Railroad Repair Work"; No. 31, "Modern Facilities for Locomotive Running-Gear Repairs"; and No. 32, "Locomotive and Boiler Tank Shops."